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BIOCHEMISTRY.—*The effect of cortisone on the incorporation of C-14 in various tissues from 2-C-14 labeled alanine.*[1] W. C. HESS and I. P. SHAFFRAN, Georgetown University Schools of Medicine and Dentistry.

(Received January 15, 1958)

The incorporation of C-14 from 2-14-C labeled DL-alanine in glycogen and protein from liver and skeletal muscle of albino rats following single injections of cortisone acetate was reported by Hess and Shaffran (*1*, *2*). While C-14 was rapidly incorporated into liver glycogen, its release, in control animals, was also rapid. In cortisone acetate treated animals, the specific activity of the liver glycogen increased up to 40 hours and then declined slowly. Cortisone acetate slightly increased the degree of incorporation of C-14 into liver but not muscle protein.

These experiments provided no answer to the question whether cortisone was acting by preventing the incorporation of the amino-acid carbon into peripheral tissue protein, hence making it available for glycogen synthesis or whether cortisone was stimulating breakdown of tissue protein. The extra nitrogen excreted in the urine of the cortisone treated rats was sufficient to explain the amount of liver glycogen formed, as was previously found by Long, Katzin, and Fry (*3*). However, when the nitrogen is considered in terms of muscle tissue, the amount is insufficient to account for the weight loss of the animals.

The present experiments were designed to attempt to provide answers to the question whether cortisone acted antianabolically or catabolically. Two series of experiments were planned. In the first, the labeled alanine was fed for several days, to establish the extent of incorporation of C-14 in tissue protein, lipide, nonprotein nitrogen and glycogen. Then the effect of cortisone on the rate of release of the C-14 was determined. Second, the labeled alanine was fed for three days and cortisone was injected at the same time. The first experiment would offer evidence on the catabolic effect of cortisone and the second on the anti-anabolic effect. The results suggest that the action of cortisone is primarily catabolic for peripheral protein but not lipide.

## EXPERIMENTAL

Rats, weighing 100 to 150 g, were kept on standard laboratory diet and given 2-C-14 DL-alanine together with 500 mg carrier DL-alanine daily for three days. The total dose of C-14 fed varied between 1.0 and 1.5 $\times$ $10^7$ cts./min. In the first series of experiments the control animals were fasted on the fourth and fifth days and then sacrificed. The test animals were given 5 mg of cortisone acetate in the middle of the fasting period, 24 hours before sacrifice. In the second series of experiments the fed rats received the same amounts of alanine as in the first series and 5 mg of cortisone acetate for three days and then were sacrificed. The controls were similarly treated except they received no cortisone.

The methods for the administration of alanine, determination of liver and muscle glycogen and protein, and their radioactivity have been previously described (*1*, *2*).

Nonprotein nitrogen was determined in the trichloracetic acid filtrate from the

[1] This work was done under a contract with the Atomic Energy Commission.

precipitation of the protein. The muscle and liver proteins were exhaustively extracted with alcohol and ether to obtain the total lipide fractions. The separation of the carcass into the nonprotein nitrogen, lipide, and defatted residue was done by the method of Clark (*4*).

## RESULTS

Table 1 contains the basic analytical data on body and liver weights, lipide, and glycogen content from both series of experiments. The values in all cases represent the average from experiments on six to eight animals. Table 2 contains all the results of the nitrogen determinations on the tissues, the nonprotein nitrogen fractions, and the urine. The values are expressed as mg N per 100 g final body weight for the liver protein and NPN, as percent for the muscle protein and mg/g muscle for the muscle NPN. Table 3 contains the data on the estimation of the radioactivity due to the incorporation of the C-14 from the administered labeled alanine in the nitrogen containing fractions. All the values are calculated in counts per minute per mg nitrogen. In Table 4 the C-14 content of the total lipide fractions are presented calculated as counts per minute per mg lipide.

TABLE 1.—BODY WEIGHT, LIPIDE, AND GLYCOGEN VALUES

| | Expt. 1 | | Expt. 2 | |
|---|---|---|---|---|
| | Cortisone last 24 hours | | Cortisone continuous | |
| | *Control* | *Test* | *Control* | *Test* |
| Initial wt. g. | 145 | 152 | 156 | 157 |
| Final wt. g. | 156 | 147 | 161 | 154 |
| Liver wt. g. | 3.9 | 4.4 | 5.5 | 6.9 |
| Liver wt. g./100 g. body wt. | 2.5 | 3.0 | 3.4 | 4.5 |
| Liver lipide percent | 4.0 | 4.3 | 5.5 | 6.3 |
| Muscle lipide percent | 2.8 | 3.2 | 3.0 | 3.9 |
| Carcass lipide g. | 1.5 | 1.7 | 1.6 | 2.0 |
| Liver glycogen percent | 0.1 | 1.5 | 6.4 | 8.2 |
| Muscle glycogen percent | 0.6 | 0.7 | 0.8 | 1.1 |

TABLE 2.—TISSUE NITROGEN VALUES

| | Expt. 1 | | Expt. 2 | |
|---|---|---|---|---|
| | Cortisone last 24 hrs. | | Cortisone continuous | |
| | *Control* | *Test* | *Control* | *Test* |
| Liver protein* | 96 | 100 | 113 | 126 |
| Carcass, N mg. | 1700 | 1620 | 1880 | 1740 |
| Muscle protein percent | 3.3 | 3.1 | 3.4 | 2.9 |
| Liver NPN* | 34.8 | 47.3 | 21.4 | 27.3 |
| Carcass NPN, N mg. | 112 | 99 | 149 | 116.6 |
| Muscle NPN, mg. mg./g. muscle | 4.3 | 3.2 | 4.5 | 3.2 |
| Urine, mg | 530 | 602 | 430 | 548 |

* mg. N/100 g. body weight.

## DISCUSSION

In experiment 1, designed to test whether cortisone acetate acted catabolically, the control animals showed substantial accumulation of C-14 activity in both liver and muscle protein, and also in the total carcass. The several lipide fractions likewise showed incorporation of C-14. When cortisone acetate was administered for the last 24 hours the liver protein showed an increase not only in total protein but also in C-14 incorporation, the activity per mg protein nitrogen rising from 144 to 162 counts per minute. The activity in the NPN fractions of the liver increased while that of both carcass and muscle decreased. The activity of the muscle protein decreased as well as the protein nitrogen content. It is apparent that as far as muscle and total carcass protein is concerned cortisone acts catabolically. As far as liver protein is concerned this is not the case nor does it hold for lipide. All the lipide fractions were higher in absolute amounts and slightly higher in specific activity.

Experiment 2, in which cortisone was administered simultaneously with the labeled alanine, indicated that the specific activity and nitrogen content of the muscle protein was less than that of the controls. In the 3-day period the specific activity of the muscle protein decreased 37 percent and of the carcass protein 32 percent. In the first experiment in which cortisone was administered after the labeled carbon had been laid down in the tissue, and the cortisone given for only the last 24 hours of a 5-day period, the decreases in specific activity of the muscle and carcass protein were 30 and 26 percent, respectively. It

TABLE 3.—CARBON-14 ACTIVITY IN TISSUE AND URINE, COUNTS/MIN./MG. N.

| | Expt. 1 | | Expt. 2 | |
|---|---|---|---|---|
| | Cortisone last 24 hrs. | | Cortisone continuous | |
| | *Control* | *Test* | *Control* | *Test* |
| Liver protein | 144 | 162 | 159 | 185 |
| Muscle protein | 80 | 56 | 104 | 65 |
| Carcass | 58 | 43 | 76 | 52 |
| Liver NPN | 93 | 132 | 72 | 126 |
| Muscle NPN | 5 | 3 | 18 | 12 |
| Carcass NPN | 8 | 6 | 16 | 11 |
| Urine | 1132 | 1010 | 1200 | 840 |

TABLE 4.—CARBON-14 ACTIVITY IN LIPIDES, COUNTS/MIN./MG. LIPIDE

| | Expt. 1 | | Expt. 2 | |
|---|---|---|---|---|
| | Cortisone last 24 hrs. | | Cortisone continous | |
| | *Control* | *Test* | *Control* | *Test* |
| Liver | 31.5 | 35.5 | 44.5 | 50.0 |
| Muscle | 15.3 | 21.1 | 22.8 | 32.6 |
| Carcass | 12.4 | 14.4 | 18.0 | 26.0 |

would appear that experiment 2 does not give an unequivocal answer to the question whether the cortisone acts solely catabolically or antianabolically. There was some reduction in specific activity of muscle and carcass protein, but this was probably due to the fact that the dominant catabolic effect was being exerted on the labeled carbon as soon as it was incorporated. In both experiments the specific activity of the liver protein was increased and likewise that of the liver and tissue lipides. The specific activity of the NPN of the liver increased whereas that of the muscle and carcass decreased. Clark (*4*) observed an increase in the NPN fraction of the liver and a decrease in the carcass NPN following cortisone and Ingle et al. (*5*) found that it induced a significant increase in the concentration of plasma amino acids. Clark also found a decrease in carcass nitrogen following cortisone. In both experiments reported here there was a decrease in carcass nitrogen and an increase in urine nitrogen in the test animals.

An increase in lipide content of liver, muscle, and carcass produced by cortisone acetate was noted in both experiments. This occurred despite the fact that in both experiments there was a loss of weight in the test animals. The increase in liver lipide has been noted by others, Silber and Porter (*6*), G. Sala et al. (*7*), and S. L. Einhorn et al. (*8*). The decrease in weight is probably due to loss of water as was suggested by Cavallero et al. (*9*) and Hedon (*10*). Kyle et al. (*11*) found that hydrocortisone administered to patients produced a significant increase of total body fat as determined by specific gravity measurements. The loss in tissue protein as indicated by urine nitrogen increase is insufficient to account for the loss in weight, an observation also made by Clark (*4*).

The concept that the action of cortisone is catabolic is supported by the recent work of Grossman et al. (*12*). These investigators gave I-131 labeled serum albumin to patients and measured the effects of hydrocortisone on turnover. They found it increased the breakdown of the albumin but that anabolic effects were unchanged or only slightly decreased. Fritz (*13*) fed N-15 glycine to rats and found that cortisone enhanced protein catabolism and suggested that it induced a protein mobilization from the periphery to the liver at a rate faster than the liver could catabolize it.

Cortisone increased the liver glycogen in both series of experiments. In series one where the 24-hour fast prior to the administration of the glycogen depleted the liver glycogen, cortisone produced a large increase in glycogen. In series two where the animals were fed continuously, the cortisone produced an increase of almost 30 percent in liver glycogen even though the control livers contained 6.4 percent glycogen. Slight increases in muscle glycogen were also found in both series of experiments.

## SUMMARY

The effect of the administration of cortisone acetate on the incorporation of C-14 from 2-C-14 labeled alanine into tissue protein and lipide was investigated. Two series of experiments with rats were run. In the first series the animals were given the labeled alanine for three days to permit incorporation of the tag into tissue. They

were then fasted for 24 hours to deplete liver glycogen, given 5 mg of cortisone acetate and sacrificed after an additional 14-hour fast. The control animals accumulated the tagged carbon into muscle, liver, and carcass protein and lipide. The cortisone acetate treated animals showed an increase in liver protein, lipide, and glycogen content and also increased specific activity. Muscle and carcass protein and specific activity were markedly decreased. Muscle and carcass lipide was increased and specific activity was slightly increased.

In the second series the labeled alanine and cortisone acetate were given simultaneously to the animals for three days. The specific activity and total amount of liver protein and lipide were increased. The muscle and carcass protein was reduced in amount and the specific activity was likewise decreased. Muscle and carcass lipide was increased and then specific activity was increased.

The first experiments indicate that as far as muscle and carcass protein is concerned, the action of cortisone acetate is catabolic, and anabolic for liver protein, muscle, liver, and carcass lipide. The second experiment indicates that cortisone acetate did not prevent the accumulation of C-14 in muscle and carcass protein but it did reduce the amount, and it also reduced the amount of protein formed. This could be interpreted as non-interference with anabolism but the immediate exertion of a catabolic effect on both the newly formed and existing protein.

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*As I grow old I grow calm. If I feel what are perhaps an old man's apprehensions, I do not lose my hopes. I do not pin my dreams for the future to my country or even to my race. I think it probable that civilization somehow will last as long as I care to look ahead—perhaps with smaller numbers, but also bred to greatness and splendor by science. I think it is not improbable that man, like the grub that prepares a chamber for the winged thing it has never seen, but is to be—that man may have cosmic destinies that he does not understand. And so beyond the vision of battling races and an impoverished earth I catch a dreaming glimpse of peace. Perpetual inspiration is as necessary to the life of goodness, holiness, and happiness as perpetual respiration is necessary to animal life.*—William Law

GEOLOGY.—*Taxonomy versus stratigraphy.* DAVID NICOL, Southern Illinois University, Carbondale, Ill.

(Received January 6, 1958)

Nomenclatural designations should serve to clarify, not obscure, taxonomic relationships, and the practical needs of stratigraphers should in no way hinder this goal. The application of formal nomenclature to every variant in a fossil population is a common practice among stratigraphers, who seek to name each form which has stratigraphic significance; but this practice confounds the true purpose of taxonomy. The problem is well stated by Newell and by Kermack in the symposium on *The species concept in palaeontology*. Newell (p. 66) says:

> Morphologic forms artificially extracted from whole populations (e.g., polymorphs, ontogenetic stages, ecotypes, and individual variants) often are given formal Latin names as varieties or species. This action is defended on the grounds that all distinctive fossil forms are actually or potentially indices of stratigraphic horizon, hence deserving of separate recognition. As far as it goes there is some logic in this argument but the point of view on which it is based actually defeats one of the ultimate objectives in stratigraphy, which is the establishment of detailed, interregional fossil zones based on evolutionary development.

And on page 73 Newell reiterates:

> It hardly seems appropriate to burden international nomenclature with binominal or trinominal Latin names for categories which at best have only local stratigraphic value and are devoid of evolutionary significance. Yet palaeontologists who favour the naming of artificial categories of scope less than whole populations unconsciously support the limited objectives of local and temporary advantage over the long term goal of world-wide stratigraphic zonation based on evolutionary succession. The individual variants might better be designated, if necessary, by non-Linnaean, vernacular names or numbers.

And Kermack states succinctly (p. 101): "Palaeontology in general suffers from too many species rather than too few."

In general, problems of this sort arise when one is dealing with species which have wide geographic and stratigraphic ranges and have numerous individuals.

The Newell and Kermack contentions are well exemplified and supported by consideration of the species *Glycymeris americana*, which is found from Virginia to Florida from the late Miocene to the Recent. During the latest Miocene this species was exceedingly numerous and variable. The most striking variant is what I have termed the mutant rugose (Nicol, 1953, p. 451). The rugose form was given a species name by Conrad, *quinquerugata*; but Dall (1898, p. 610) and Gardner (1943, pp. 27–28) have synonymized *quinquerugata* with *americana*. Dall (p. 611) thought that the rugose form was due to some pathologic cause.

The earliest specimens of *Glycymeris americana* do not have rugae or folds on the posterior side of the shell, but toward the end of the late Miocene rugose forms bɘgan to appear in populations along with normal forms. There is no other consistent difference between normal and rugose forms except for one or more folds or rugae which are located on the outside of the shell and which are nearly always on the posterior side. (Apparently further mutations of some of the rugose mutants gave rise to the rare species *Glycymeris aberrans* at the very end of the Miocene, but this species is of no concern in the present discussion.) Rugose mutants became more and more abundant and spread to populations covering practically the entire geographic range of *Glycymeris americana* until the end of the Miocene, and then they suddenly disappeared. Specimens of *Glycymeris americana* from Pliocene and younger strata never have folds or rugae. There appear to be no geographic or ecologic differences between normal and rugose forms. Collections from late Miocene strata contain both forms in various percentages.

There is no doubt that the rugose forms have stratigraphic significance, certainly more so than the normal forms of *Glycymeris americana*. However, the problem is how to designate the rugose mutant. The

average stratigrapher would prefer a formal Latin name, which, preferably, would have some official nomenclatural standing. From the purely biologic or strict taxonomic view this is unfortunate. I agree with Dall and Gardner that there is no reason to consider the rugose variant as a distinct species. Furthermore, this mutant cannot be considered a subspecies by definition. One could refer to the rugose forms as *Glycymeris americana* variety *quinquerugata*, but I object to this solution for two reasons: (1) There is always the possibility that some paleontologist will unwittingly raise the varietal name to that of a subspecies or a species without at least stating his reasons for doing so. (2) The term or category "variety" is a sort of catchall and really tells us nothing about the variant. My preference, as I stated in 1953, is to term the form *Glycymeris americana*, rugose mutant. If one would prefer in this case, the term "polymorph" can be used instead of "mutant", for *Glycymeris americana* is certainly a polymorphic species. (Recommended procedure for the term or terms following the species or subspecies name is to set off the description with a comma. However, this is, as yet, not followed by many taxonomists.) Either phrase—"rugose mutant" or "rugose polymorph"—has the advantage of expressing the biologic relationship of the rugose form to the normal form. In this way the stratigraphers can keep the integrity of the variant without confounding its true taxonomic position.

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*Truth is the foundation and the reason of the perfection of beauty, for whatever stature a thing may be, it cannot be beautiful and perfect, unless it be truly what it should be, and possess truly all that it should have.*—ALFRED NORTH WHITEHEAD.

BOTANY.—*Two new genera of grasses from China.* Y. L. KENG, Department of Biology, Nanking University, and Chung Shan Memorial Nanking Botanical Garden, Botanical Institute, Academia Sinica. (Communicated by Agnes Chase.)

(Received December 7, 1957)

During the past few years the author and his collaborators have devoted themselves to writing in Chinese an illustrated flora of the grasses of China. Although they have intended to include in this work only the more familiar species, there are about 200 genera and 800 species described and figured in it. Among the ample material gathered from the different parts of the country, a good many novelties have been encountered in the course of their study. Two new genera are here presented for publication.

**Sinochasea**[1] Keng, genus novum tribus Agrostidearum, cum *Deyeuxia* Clarioni et *Calamagrostide* Adansoni comparandum; ab illa rhachillae continuatione minuta plerumque glabra haud penicillata, lemmate sub lobos omnino villoso, ab hac lemmatis callo breviter barbato, arista inter lobos valida, geniculata, et ab utraque glumis saepe 5- (vel inferiore 6-, superiore 4-) haud 1-3-nervibus, stigmatibus tribus distinguendum.

Spiculae uniflorae, in paniculam contractam dispositae, lateraliter leviter compressae, rhachilla supra glumas facile disarticulata, in acumen minutum glabrum supra paleam producta; glumae subaequales vel prima saepius longior, herbaceae, plerumque prominenter quinquenerves, dorso carinatae vel basin versus rotundatae, marginibus anguste hyalinis; lemma glumis brevior, lateraliter compressum vel inferne dorso rotundatum, a latere videtur anguste oblongum, profunde bilobum, aequaliter villosum, chartaceum vel inferne subcoriaceum, sed lobis glabris, superne membranaceis, quinquenerve, nervo medio valido, elevato, sed basin versus tenui, e sinu aristam geniculatam exserente, nervis lateralibus inferne obscuris, superne per lobos paralleliter percurrentibus, marginibus inter se imminentibus, paleam omnino occultantibus, callo minuto, rotundato-obtuso, breviter densiusque barbato; palea a dorso visa anguste lanceolata, bidentata, lemmate brevior tenuiorque, obscure binervis, inter nervos (carinas) adpresse villosa et superne subhyalina, marginibus inflexis, approximatis vel remotis (i.e. haud inter se imminentibus); lodiculae duae, semi-ovatae, hyalinae; stamina tria; filamenta elongata; antherae oblongae; ovarium fusiforme vel lineare, glabrum; styli tres, terminales, brevissimi stigmatibus dense plumosis; caryopsis (immatura) a lemmate paleaque libera.

Gramen perenne, caespitosum; culmi validi, simplices, paucinodosi; foliorum laminae lineares, involutae; panicula terminalis, erecta vel leviter arcuata.

Species adhuc cognita unica, in provincia Tsinghai, Chinae occidentalis, endemica.

**Sinochasea trigyna** Keng, sp. nov. (Fig. 1). Perennis glabra, basi cum vaginis vetustis brunneis et innovationibus intravaginalibus circumdata, radicibus fibrosis validis, circ. 0.8 mm. crassis, e rhizomate duro brevi ortis; culmi erecti, rigidi, teretes, circ. 45 cm alti, 1.5 mm in diametro 2-3-nodosi, nodo supremo sub medium usque ad 2/3 superiorem sito; folia pallide viridula, erecta, caulina duo vel tria; vaginae arctae, striatae, scabridulae, internodio 11–18.5 cm longo multo breviores; ligula membranacea vel firmula, truncata vel lacerata, 0.5–1 mm longa, in margines vaginae decurrens; laminae e basi angustata anguste lineares, rigidae, valide nervosae, subulato-involutae, 6.5–8.5 in innovatione usque ad 16 cm longae, expansae 1–2 raro 3 mm latae, suprema saepe valde abbreviata, setiformi, 1–2 cm longa, utrinque ut in marginibus scabrae vel ad paginam superiorem setuloso-asperae; panicula spiciformis, anguste lanceolata, 7–8.5 cm longa, circ. 1 cm lata, continua vel inferne interrupta, ramis binis, adpressis, primariis usque ad 3 cm longis, inferne plus minusve nudis, superne divisis et 4-7-spiculatis; pedicelli sicut rami setuloso-scabriduli, adpressi, laterales 0.6–1.5 terminales 3–5 mm longi; spiculae anguste lanceolatae, 10–12 mm longae, confertae, pallide viridulae vel purpurascentes, demum hiantes; glumae spiculam aequantes vel subaequantes, acuminatae,

[1] Name from a combination of *Sino-*, China, and *Chasea*, after Mrs. Agnes Chase, well-known agrostologist of the United States, who gave much help to the study of Chinese grasses.

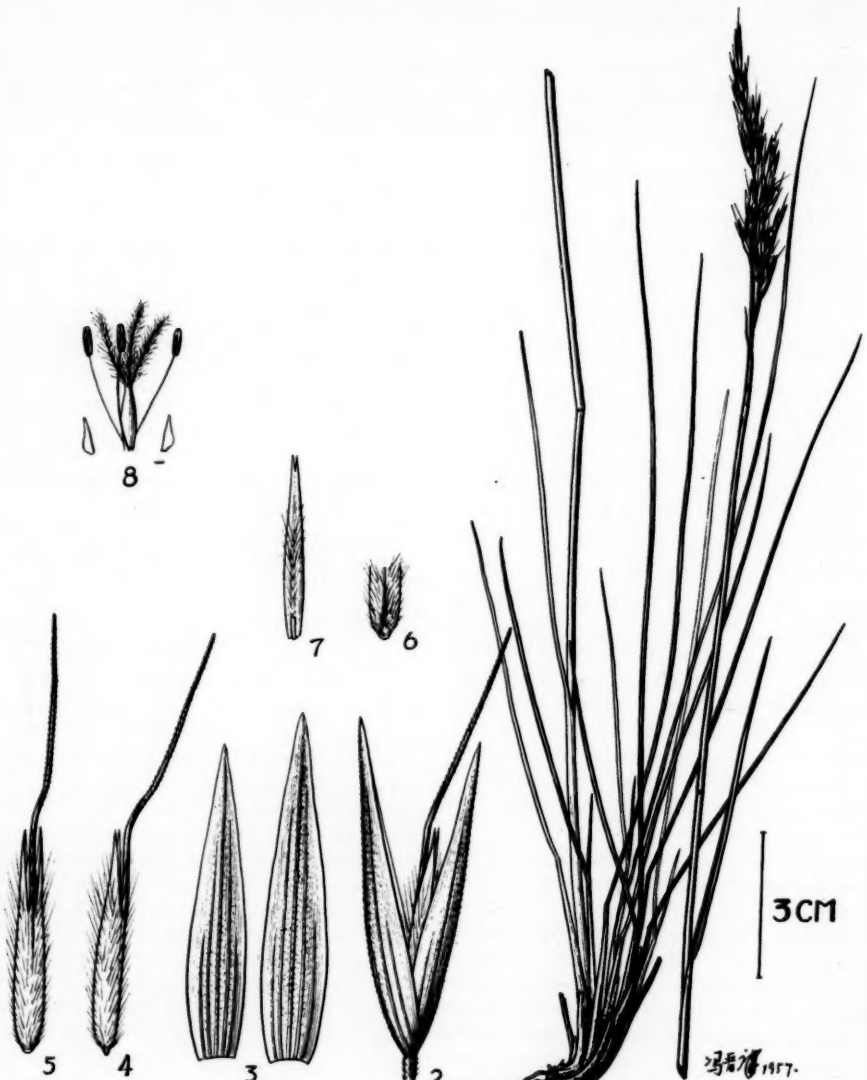


FIG. 1.—*Sinochasea trigyna* Keng: 1, Habit; 2, spikelet; 3, first and second glumes; 4, side view of lemma; dorsal 5, view of the same; 6, ventral view of the lower part of lemma showing the prolonged rachilla; 7, dorsal view of palea; 8, lodicules, stamens, and pistil. (Type.)

prima saepius quam secunda 0.5–1 mm longiore, distincte quinquenerves vel prima inferne 6-, secunda 4-nervis sublaeves vel minutissime scaberulae, saepe apicem versus recurvatae; lemma 7–8 mm longum, pilis albis circ. 2 mm longis villosum, lobis acuminatis, circ. 3 mm longis, callo pilis densis 0.5–0.75 mm longis barbato; arista scaberula, in 1/3 inferiore parte geniculata, columna laxius contorta, 3–3.5 mm, subula 7–8.5 mm longa; rhachillae processus 0.5–1 mm longus, laevis, glaber vel raro pilis 1–3 sparse pilosus; palea 6 mm longa, 0.75 mm lata (marginibus inflexis excl.), dentibus acuminatis, vix 1 mm longis, nervis (carinis) sub dentes minute ciliolatis; lodiculae anguste semiovatae, circ. 1.5 mm longae, inferne firmulae, glabrae, acuminatae vel altera saepe breviter cuspidata; antherae flavo-brunneae, 1 mm longae; ovarium purpureo-nigrescens, circ. 2 mm longum, ventraliter canaliculatum; stigmata flavo-brunnea, 2–3 mm longa; caryopsis immatura.

CHINA: Prov. Tsinghai, Hai-yen Hsien, San Chio Shen, Sheep-breeding Station, San Tui Tui Pu, 21 VIII 1954, *P. C. Yeh & W. C. Wang*, etc. 3241 (type in Herbarium of the Department of Biology, Nanking University; duplicate types in Herb. Botanical Institute, Peking, and Chung Shan Memorial Nanking Botanical Garden, Nanking).

This species is peculiar in the tribe in having three stigmas. The spikelets are probably cleistogamous, the short oblong anthers in the mature florets often being entangled with the hairs of the stigmas which, after removal of the lemma, are seen partly exposed laterally on the outside of the inflexed margins of the palea.

This genus appears to be comparable with the two closely related genera *Deyeuxia* and *Calamagrostis*, the former being regarded by some authors as a section of the latter. It is allied to *Deyeuxia* through *D. moupinensis* (Franch.) Pilger, since that species, though differing in having callus-hairs equaling the lemma, has also a geniculate awn arising from the sinus of a deeply bilobed lemma. It is also similar to such species of *Calamagrostis* as *C. Munroana* Boiss. and *C. Griffithiana* Hook. f., in which the lemma is villous all over and the callus hairs shorter than the lemma.

**Anisachne**[2] Keng, genus novum tribus Agrostidearum, *Deyeuxiae* Clarioni, arcte affine lemmate glumis longiore, gluma inferiore quam superiore plerumque breviore differt.

Spiculae uniflorae, lateraliter compressae, in paniculam dispositae, rhachilla supra glumas disarticulata, in setam minutam villosam supra paleam producta; glumae subaequales vel prima quam secunda saepius leviter brevior, uninerves vel secunda inferne trinerves, viridi-carinatae, albo-marginatae; anthoecium hermaphroditum, ad anthesin hians; lemma glumis saepe longius, tenuiter chartaceum vel membranaceum, superne obscure quinquenerve carinatumque, inferne dorso rotundatum, muticum vel sub apicem mucronatum, callo minuto dense barbato excepto glabrum; palea lemmate brevior tenuiorque, ab eo laxe inclusa vel ad maturitatem dorso exposita, bicarinata; lodiculae duae, hyalinae; stamina tria; filamenta demum elongata; antherae oblongae; ovarium obovatum, glabrum; styli duo, terminales, brevissimi; stigmata sparse plumosa, lateraliter exserta; caryopsis ellipsoidea, dorso rotundata, facie leviter sulcata, inter lemma paleamque inclusa, libera; hilum subbasale, breviter lineare; embryo parvus.

Gramen perenne, caespitosum; culmi graciles vel gracillimi, simplices, plurinodosi; foliorum laminae lineares, planae vel involutae; panicula terminalis, angusta vel ad maturitatem aperta.

Species adhuc cognita unica, Chinam austro-occidentalem inhabitat.

**Anisachne gracilis** Keng, sp. nov. (Fig. 2). Perennis glabra, radicibus filiformibus ex rhizomate duro brevi ortis, innovationibus extravaginalibus, tenuibus, erectis vel saepius decumbentibus; culmi erecti vel saepe geniculati, basi vaginis marcidis fibrosis albo-brunneis obtecti, 25–40 cm alti, 0.5–1 mm in diametro, lenes, 3-4-nodosi, nodo supremo infra vel in juventate supra medium sito; vaginae striatae, laeves, basin versus clausae, internodio 3–7.5 cm longo breviores, vel inferiores eo 12–20 mm longo leviter longiores, suprema 6–11 cm longa, quam sua lamina longiore; ligula scariosa, truncata vel obtusa, 0.5–1 vel usque ad 2 mm longa, in margines membranaceas decurrens; laminae ubique aequilata vel basi vix contracta, lineares, fusco-viridulae, firmulae, planae vel siccitate involutae, utrinque scaberulae, caulinae superiores breviores, 2.5–8.5 cm longae, 0.8–1.5 mm latae; panicula 7–16 cm longa, exserta vel basi in juventate vagina suprema inclusa, ramis filiformibus vel subcapillaribus, scaberulis, 2–3-nis, longe remotis,

[2] Name from Greek *anisos*, unequal, and *achne*, scale, referring to the unequal and successively greater length of the first glume, second glume, and lemma.

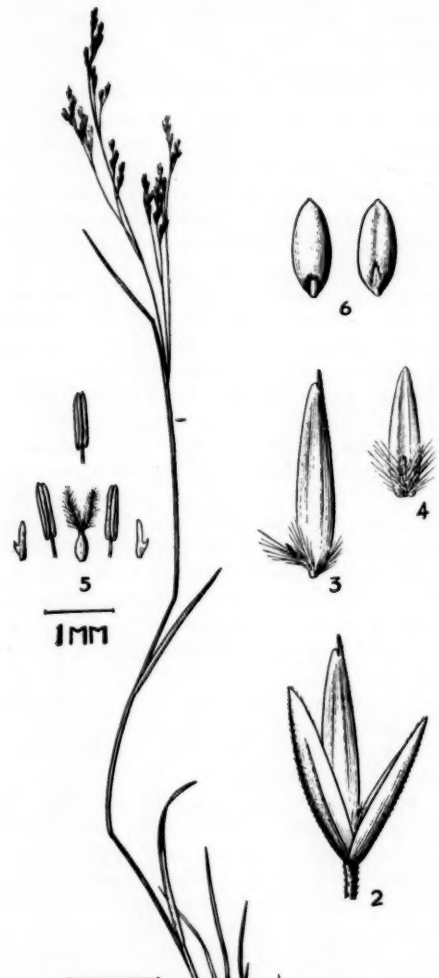


FIG. 2.—*Anisachne gracilis* Keng: 1, Habit; 2, spikelet; 3, side view of lemma with prolonged rachilla; 4, dorsal view of palea with prolonged rachilla; 5, lodicules, stamens, and pistil; 6, dorsal and ventral views of caryopsis. (1–5 from type, 6 from Wang Chi-wu 83229.)

erectis vel basalibus ad maturitatem adscendentipatentibus, primariis 3.5–8 cm longis, inferne longe nudis, superne supra vel infra medium ditrichotomis; pedicelli laterales 0.5–2 mm terminales usque ultra 3 mm longi, scaberuli, apice incrassati; spiculae circ. 3 mm longae, demum hiantes; glumae acutae vel secunda obtusiuscula, pallide viridulae, margine albo-vel purpureomembranaceae, ad maturitatem stramineae, prima 1-nervis, 2–2.5 mm longa, secunda 1-3-nervis, 2.5–2.8 mm longa, ad carinam scaberulae; lemma spiculam aequans, acutum vel sub apicem saepius mucrone 0.2 mm longo praeditum, callo pilis circ. 1 mm longis dense barbato; rhachillae continuatio penicillata, 0.3–0.5 mm longa, conjuncte cum pilis villosis lemmatis dimidium aequans; palea glabra cum lateribus inflexis anguste lanceolata, 2 mm longa, ad carinas sublaevis vel sparse minutissime scaberula; lodiculae semiovatae vel inferne trilobatae, 0.8 mm longae, glabrae; antherae fulvae, 1 mm longae; caryopsis obesa, flavo-brunnea, 1.25 mm longa.

CHINA: Prov. Kweichow, Pichieh Hsien, on acid sandy soil, altitude 1,400 meters, June 1, 1943, *Hou Hsueh-yuh* no. 2143 (type in the herbarium, Department of Biology, Nanking University, Nanking, China). Prov. Yunnan, *E. E. Maire* 6895, 6898 in part; Likiang Snow Range, *J. F. Rock* 10693; Wei-hsi, 1955, *Hu Yung-kang* without number; Mengtze, 1939–40, *Wang Chi-wu* 83229; Dali, en route from Tsang Shan Miao to Chung Ho Sze, October 2, 1946, *Liou Tchen-ngo* 21012, in part.

In the author's manuscript on the Grasses of China [unpublished] this species was misidentified as *Deyeuxia abnormis* Hook. f., which is, according to the original description given in the Flora of British India, neither a *Deyeuxia* nor an *Agrostis*. It seems that this Indian species may need to have another generic name, just as in the same Flora the next species *Deyeuxia treutleri* (Kuntze) Stapf did; the latter has been made the type of the genus *Aulacolepis* Hackel.

The new genus here described, as noted in the Latin diagnosis, appears to be related to *Deyeuxia* Clarion through the presence of a villous prolonged rachilla and a shortly bearded callus. If its glumes were longer than the lemma, it would undoubtedly be referred to the genus *Deyeuxia*, and the species would be included in the same series with awnless lemmas as is *Deyeuxia diffusa* Keng, from Yunnan, China.

# ZOOLOGY.—*A new species of* Allogaussia (*Amphipoda, Lysianassidae*) *found living within the gastrovascular cavity of the sea-anemone* Anthopleura elegantissima.

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In the spring of 1955, while on a field trip to Moss Beach, San Mateo County, California, a group of zoology students from the University of California discovered that by squeezing individuals of the aggregating anemone *Anthopleura elegantissima* they were able to obtain from the gastrovascular tract small pinkish gammarid amphipods which were obviously alive and apparently uninjured by the nematocysts and digestive enzymes to which they were exposed. Howard Law, one of the discoverers, presented in a brief unpublished paper (Law, 1955) a preliminary description of the body and of various appendages, but he was unable to correlate with certainty the characters he found with those of any gammarid family. Nevertheless he tentatively placed it within the Lysianassidae on the grounds that it resembled this family more closely than it did any other. The present study is the result of an attempt to identify this unusual amphipod.

The amphipods described below were, for the most part, collected from anemones during the latter part of December 1955 and January 1956 and were stored in 70 percent alcohol. All came from the same location; namely, the "Sand Rocks" at Moss Beach. The location name is taken from the map of Moss Beach in Light et al. (1954).

## METHODS AND MATERIALS

To assure that all spines and setae would be visible, the following method was employed in preparation of specimens for dissection. The specimens were first placed in a solution of 70 percent alcohol and fast green and left over night. They were then taken through a series of increasing alcohol concentrations (70-90-95-100 percent) to clove oil, in which they were allowed to clear and harden. The brittleness given to the specimens by the clove oil proved a great aid in dissections as the appendages could be separated from the body without tearing. The stained and dissected amphipods were mounted in clove oil under a cover glass and observed with a compound microscope. Approximately 30 individuals were treated in this way. The figures were drawn with the aid of a camera lucida.

## DESCRIPTION OF THE GENUS

A review of the literature has revealed that there are no less than 110 genera in the Lysianassidae, the family to which the present species belongs. Of these, 48 are described in Stebbing's monograph (1906). The genus *Allogaussia* Schellenberg (1926) as modified by K. H. Barnard (1932) seems to include the present species with two further points of expansion necessitated by the inclusion of the amphipod described below. In the following translation of the original description of the genus by Schellenberg, Barnard's addenda are given in parentheses. Expanded characters applying only to the present species are included in the description.

*Description.*—Body broad. Coxae long. (Side-plate 4 may or may not fit into a groove on side-plate 5.) Third epimeral plate not produced to a tooth. Telson short and rounded or sinuous (or long and notched or shallowly or deeply cleft). Antennae of nearly equal length (stout in both sexes); second joint of peduncle of antenna I relatively long, (or very short compared with its breadth, with third joint easily visible dorsally, ventrally entirely masked on inner side by first joint of flagellum). (First flagellar joint stout and elongate, first joint of accessory flagellum also elongate.) Flagellum of antenna II in the male not long. Epistome arched forward over the upper lip, (with a narrow notch separating it from the upper lip). Cutting edge of the mandible simple with a subterminal "canine tooth." Molar of moderate size, channeled. Palp arising behind the molar; first joint short, second joint longer than the third. Inner lobe of maxilla I

with two terminal setae. Inner lobe of maxilla II somewhat shorter and more slender than the outer lobe, both lobes slender. Maxillipeds well developed. Gnathopod I powerful, subchelate or slightly chelate as in the species described below (Fig. 3, J). Metacarpus longer than the carpus. Gnathopod II chelate. Peraeopods 5–7 short. Base of peraeopod 5 peculiarly broadened or not "peculiarly" broadened as in the present species (Fig. 3, R). Base of peraeopod 7 broad. Uropod II considerably surpasses the shorter ones; also, in the nonsetose uropod III of the male the inner ramus is shorter than the 2-jointed outer ramus, (or uropod III is slightly longer with setae on both rami). Near *Orchomenella*.

Since no type species has been assigned *Allogaussia*, I wish to designate *A. paradoxa* Schellenberg as such.

Schellenberg gives three species of *Allogaussia*; Barnard adds two others. Of the five named species, not one corresponds completely to the one discovered at Moss Beach; therefore, the following name and description are proposed for the new species.

## DESCRIPTION OF **Allogaussia recondita**, n. sp.

*Allogaussia recondita*, n. sp. (Fig. 1). The specific name comes from the Latin, *reconditus* = hidden, and refers to the distinctive microhabitat in which this species is found.

*Diagnosis.*—*Allogaussia recondita* is distinguished from all previously described members of the genus by the following characters: The slightly chelate gnathopod I; the relatively weak broadening of the base of peraeopod 5; the shallow excavation in the posterior margin of the second joint of peraeopod 7; the produced apex of the typical female telson; the extremely deep emargination of the medial edge of the third joint of antenna I in the male; the distal accessory branchia on peraeopod 4; and by the combination of a setose uropod III (in the male) and the absence of a groove on side-plate 5 into which side-plate 4 fits. The association with *Authopleura elegantissima* is likewise unique.

*Description.*—Integument smooth. Body compact, broadly rounded dorsally in both sexes. Head with anterolateral angle acutely produced with the angle itself rounded. Eyes large and kidney-shaped with the concave margin anterior. Facets of eyes bright red in life, with interstices between facets white. Side-plates 1–3 long, 1 more rounded ventrally than 3; 4 (Fig. 3, M) longer and broader than the others, with a long rounded posterior excavation, the posterior projection broadly rounded, not fitting into a groove on side-plate 5 (Fig. 3, R). The base of peraeopod 5 (Fig. 3, R) expanded posteriorly, but not to the same exaggerated extent as in other species of *Allogaussia*. Side-plate 7 (Fig. 3, S) small, with rounded posterior margin longer than anterior margin and as long as ventral margin; the whole trapezoidal in shape. The second joint of peraeopod 7 with a shallow rounded posterior excavation. Pleon dorsally rounded with a low rounded medio-dorsal keel on segment 4; posteroinferior angle of segment 3 not produced, margin entire. Telson of adults of both sexes variable; typically triangular in the female (Fig. 3, P, Q) with the blunt, usually weakly notched apex produced beyond a pair of short spines, each of which bears a small lateral seta; telson in the male sometimes resembling that of the female but often broader and more rectangular with the terminal notch, if present, deeper and broader, the apex not produced beyond a pair of apical spines. A fine seta laterally placed to each of the spines may be present in either sex. Usually there are one or two pairs of narrow setae submarginally placed midway between apex and base of telson in both sexes.

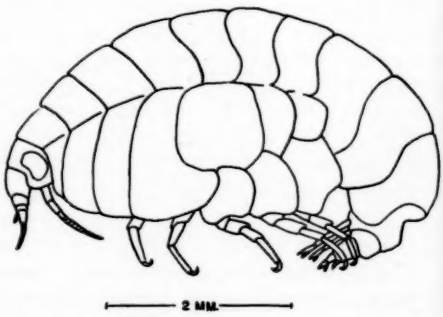


FIG. 1.—*Allogaussia recondita*. n. sp.: Mature male. For clarity, the pleopods are not shown.

Antenna I stout in both sexes, slightly longer in male (Fig. 2, A) than in female (Fig. 2, B), first joint very stout, medially flattened, lateral setae (Fig. 2, B) with fine long distal projections; second joint short; third joint visible from all sides, distal medial margin deeply emarginated in male exposing stout elongate first joint of flagel-

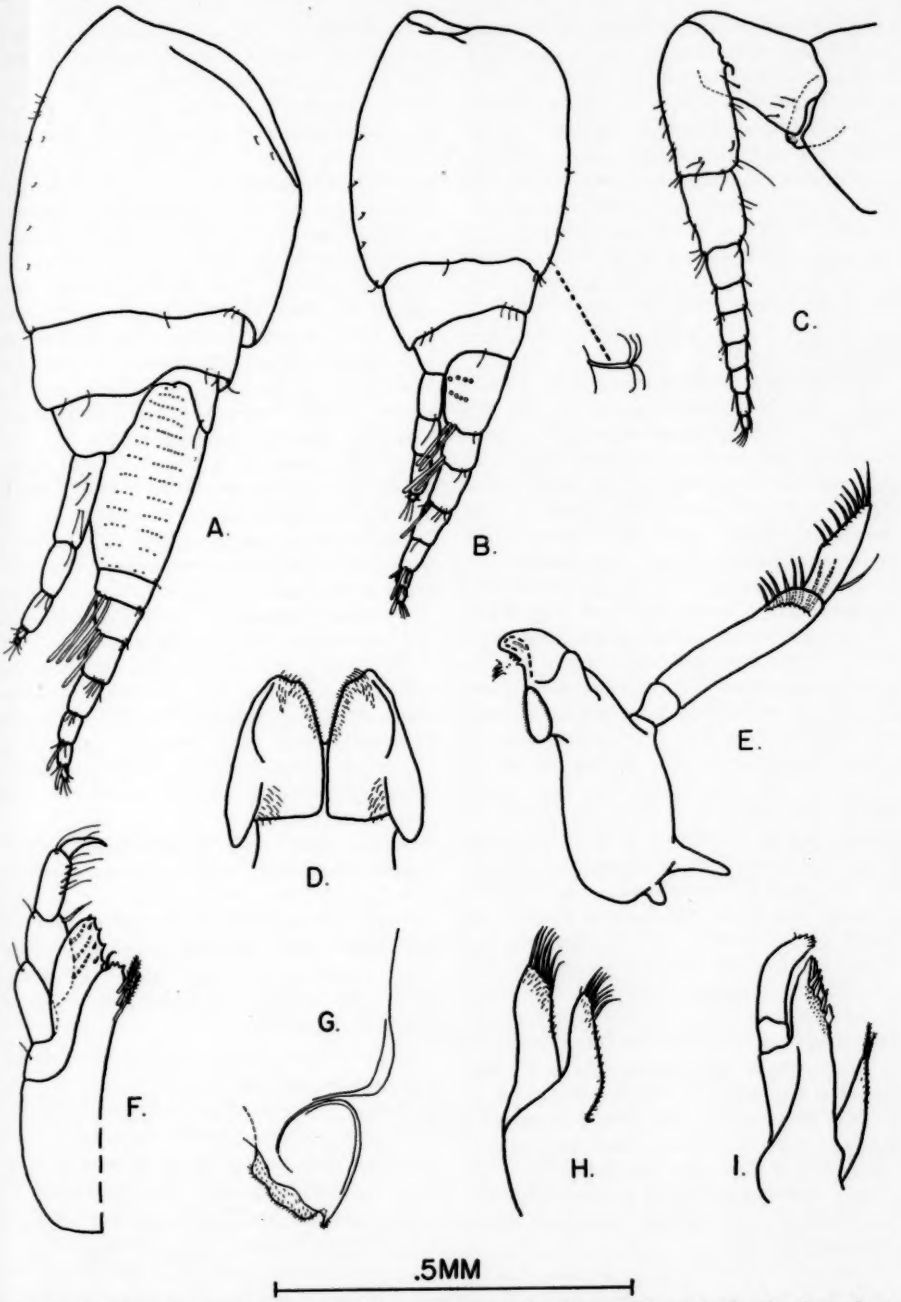


FIG. 2.—*Allogaussia recondita*, n. sp.: A, antenna I, male; B, antenna I, female, showing lateral seta enlarged; only origins of setae of first flagellar joint shown in both A and B; C, antenna II; D, lower lip; E, mandible, variation in length of spines of spine-row indicated; F, maxilliped; G, upper lip and epistome;, H maxilla II; I, maxilla I.

lum which bears two longitudinal groups of many heavy setae on medial surface; first flagellar joint in female not elongate, with few setae on medial surface. Flagellum of antenna I in male 8-jointed, rarely 9- or 10-jointed, in female usually 7-jointed though may be 6- or 8-jointed; accessory flagellum 4- rarely 5-jointed, first joint elongate in male, sparsely setose on ventromedial surface. Antenna II (Fig. 2, C) subequal in length to antenna I, with prominent gland cone; peduncle acutely flexed ventrally between joints 3 and 4, joint 4 the longest; flagellum slightly longer in male than in female, 8-10–jointed in male, 5-7–jointed in female.

Epistome (Fig. 2, G) produced in an arching manner over the rounded upper lip, the two separated by a deep, narrow sinus. Anterior margin of epistome sinuous. Mandible (Fig. 2, E) with rounded cutting edge and without terminal denticles, a single elongate blunt seta on the concave medial surface, spine row of three curved spines, molar well developed, finely denticulated, the denticles arranged in rows. Accessory plate between cutting edge and palp blunt. Palp as long as trunk, inserted just behind molar; second joint twice as long as third and with a row of setae on distal margin; third joint tapering distally and bearing a row of setae on distal margin, typically with a single long seta proximally placed on margin opposite from that bearing the row of setae. Lower lip (Fig. 2, D) with distal apices slightly excavated, lateral lobes only slightly divergent. Maxilla I (Fig. 2, I) with inner lobe tapering with two terminal plumose setae, outer lobe with 10 or 11 serrate spines, palp 2-jointed, the first joint short, the truncate apex of the second joint extending beyond outer lobe and bearing 5 or 6 stout setae and one fine marginal seta. Maxilla II (Fig. 2, H) with both lobes narrow, the inner lobe narrower than the outer and not quite as long; apices of both lobes setose on inner margins. Maxillipeds (Fig. 2, F) with inner lobe long with three stout terminal spines, one long terminal seta, and three plumose setae on inner margin; outer lobe extending to apex of second joint of palp, inner margin bearing a row of small nodulous teeth and a submarginal row of small setae; palp 4-jointed, fourth joint curved and acuminate.

Gnathopod I (Fig. 3, J) slightly chelate, second joint straight, setose on anterior margin, fifth with anterior margin twice as long as posterior margin, the distal posterior margin rounded, posterior margins of fourth and fifth joints finely setose, sixth joint only slightly longer than fifth, anterior and posterior margins parallel, palm convexly rounded with two spinules at distal posterior angle; dactylus slender, slightly overreaching palm. Gnathopod II (Fig. 3, K) minutely chelate, very slender, second joint slightly less than twice as long as third, fifth joint twice as long as sixth, sixth joint oblong with anterior margin rounded and bearing dense long setae; dactylus (Fig. 3, L) with one long seta on anterior margin and two blunt setae subterminally placed on posterior margin.

Uropod I longer than uropod II, outer ramus slightly longer than inner, rami of both I and II acuminate: uropod III shorter than others and relatively stouter, projects slightly beyond others posteriorly, inner ramus shorter than outer, outer ramus with a small second joint, inner margin of outer ramus nonsetose in female (Fig. 3, N), with 3-6 long plumose setae in male (Fig. 3, O).

Oostegites (Fig. 3, K) elongate, narrow, armed with 5 or 6 long distal setae. Branchiae simple on peraeopod 2 (= gnathopod II) and peraeopod 3, a single elongate distal accessory branchia on peraeopod 4 (Fig. 3, M), and a single proximal accessory branchia laterally placed on both peraeopods 5 and 6.

Color, pinkish or yellowish with minute irregular golden flecks scattered upon the body.

Length, 4–5 mm when at rest.

Types: The following have been deposited in the United States National Museum: (1) Holotype, 1 adult male, 4 mm. long, U.S.N.M. no. 99978; (2) paratypes, 6 males and 6 females, U.S.N.M. no. 99979.

Type locality, "Sand Rocks," Moss Beach, San Mateo County, Calif.

Range, unknown. Besides the type locality, this species has been found in *Anthopleura* at two locations near Bodega Bay, Sonoma County, Calif.; namely, the north jetty bordering the entrance to Bodega Harbor, and the rocks just east of Doran Beach.

FIG. 3.—*Allogaussia recondita*, n. sp.: J, Gnathopod I; K, gnathopod II and oostegite; L, enlarged dactylus of gnathopod II; M, side-plate 4 with attached branchia; N, uropod III, female; O, uropod III, male; P, telson, female; Q, telson enlarged; R, peraeopod 5; S, peraeopod 7.

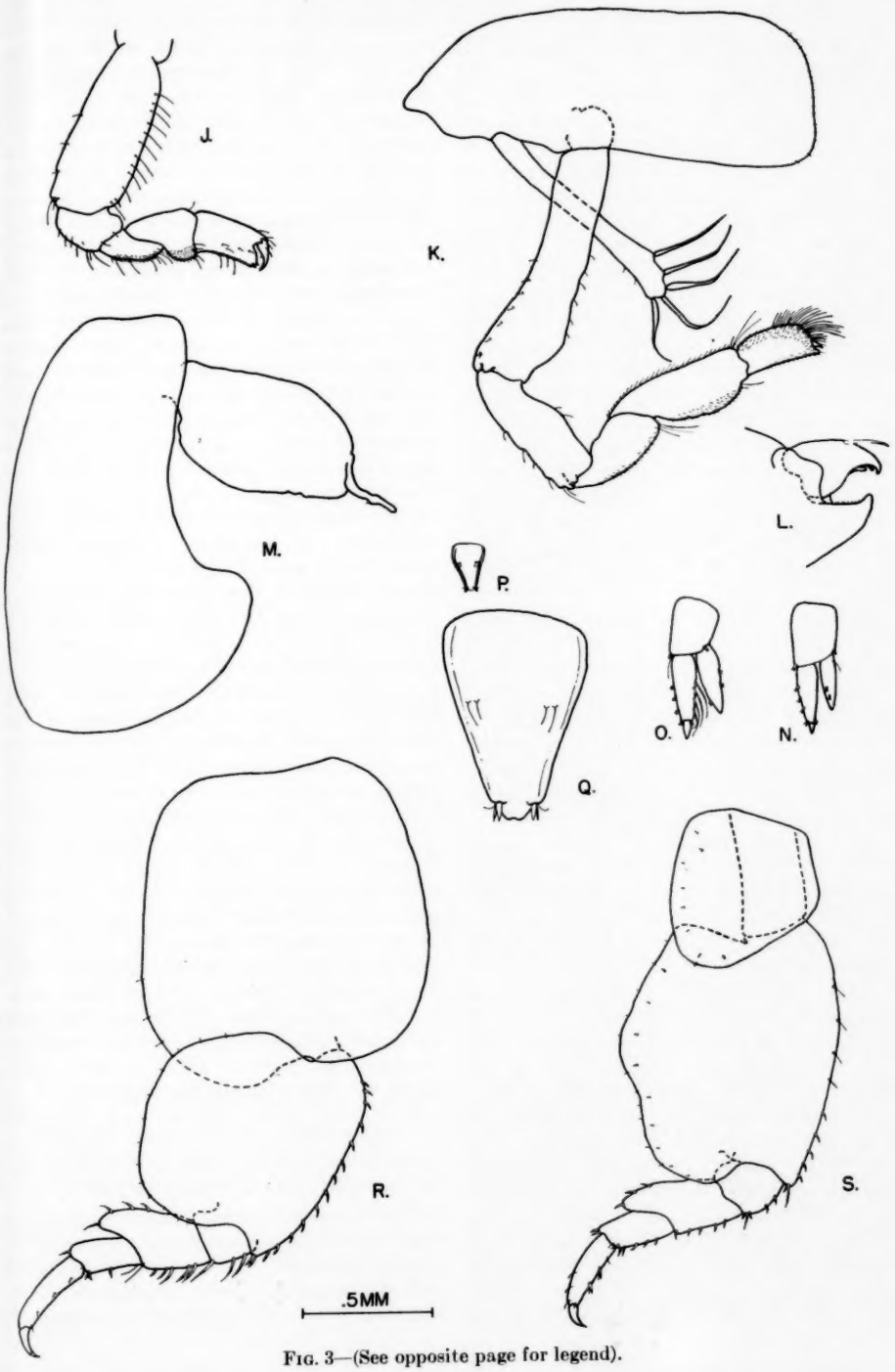


FIG. 3—(See opposite page for legend).

## DISCUSSION

The genus *Allogaussia* is probably a heterogeneous one. It is Barnard's expansion of *Allogaussia* that makes it possible to include the present species in the genus. Schellenberg's original description would exclude it on the basis of uropod characters: the second projecting furthest in his species, the third in those of Barnard and in the species from *Anthopleura*; the third uropod not being setose in the males of Schellenberg's species, but being so in *Allogaussia recondita* and in those described by Barnard. The expansion of *Allogaussia* by inclusion of Barnard's species in the genus also affects the following generic characters: the relative size of the second peduncular joint of antenna I and the strange masked condition of the third peduncular joint of this appendage; also the degree of emargination of the telson whereby there is now a gamut from short and entire or slightly emarginate to long and slightly or deeply cleft representatives.

Barnard (1932, p. 64) makes the point that, "the 1st antenna [of his species] is entirely different [from those described by Schellenberg] and in conjunction with the character of the side plates almost makes a separate genus advisable." A new generic name was not proposed by Barnard, however, and the expanded concept of *Allogaussia* must stand, for the time at least.

The further expansion of the genus demanded by the inclusion of *Allogaussia recondita* within it serves to emphasize the probable heterogeneity of *Allogaussia*, and will, perhaps, lend impetus to a thorough analysis of this genus.

Many authorities have presented single numbers to indicate the number of joints in the flagella of antenna I and antenna II, and have used such numbers as specific characters (e.g. Barnard in describing *Allogaussia navicula*, p. 65). Such designations in the present species are not possible. Not only do the numbers of flagellar joints vary through ontogeny, but adults of the same sex and of comparable size display varying numbers of such joints. Even flagella from opposite sides of a single individual may present different numbers of joints. In the latter case, which is not uncommon, the difference is of one joint only. The detailed studies of Sexton (1924) on *Gammarus chevreuxi* and of Segerstrale (1937) on *Pontoporeia affinis* as well as the more recent works of Nayar (1956) on *Grandidierella bonnieri* and of Clemens (1950) on *Gammarus fasciatus* have shown that differences in numbers of antennal joints are related to degree of maturity; therefore, a range of values for these characters seems more logical than a single number and has been employed in the preceding description.

The character of the telson is likewise variable in the new species. The typical picture of the telson in the female is presented in the description (Plate 2, P, Q), but the lateral edges may be concave instead of nearly straight, thus the telson appears to bulge greatly towards the base. In some cases, egg-bearing females were seen to have emarginated telsons. In the male the degree of apical emargination varies from almost no excavation at all to a very broad, though shallow, concavity. Immature stages were not studied in detail, although it was noticed that telsons of individuals about ready to be released from the brood pouch bore a relatively deep emargination, and that immature individuals free of the parent's pouch presented deeper emarginations than the larger adults. The degree of emargination apparently decreases with age.

The occasional presence of supernumerary spines on the telson is a further variable feature of this species. One immature female was observed to have a single asymmetrically placed supernumerary spine on the terminal margin of the telson. The telson of a mature male bore two such supernumerary spines: one on either side of the median line. Of these, one was marginally placed while the other was submarginal in location. All observed supernumerary spines bore a lateral seta.

## PRELIMINARY OBSERVATIONS ON THE ASSOCIATION OF A. RECONDITA AND ANTHOPLEURA ELEGANTISSIMA

The association of *Allogaussia recondita* and *Anthopleura elegantissima* remains to be studied in detail, but a few observations will be reported here. Amphipods were collected when the anemones were exposed

at low tide. At these times no amphipods were found outside the anemones, but only within the gastrovascular tract among the gastric filaments which they resemble in color. Anywhere from three to 12 specimens were collected from each anemone. Inspections of neighboring *Anthopleura xanthogrammica*, a closely related species, did not reveal the presence of *Allogaussia*, and it was felt that this absence demonstrated some host specificity on the part of the amphipod. When anemones bearing amphipods were removed to the laboratory and placed in an aquarium of sea water, the amphipods crawled out through the stomodaeum and onto the oral disc as the anemones expanded. From there they wandered about the bases of the tentacles and even onto or over these structures, suffering no apparent harm. Occasionally a specimen could be seen on the column of an anemone. When forcibly pushed into the tentacular mass and then removed, it could be seen that the amphipod "stuck" to the tentacles, but that it was able to continue on its way apparently uninjured. One very small *Allogaussia* was seen to race rapidly up and down a tentacle without being impeded in any way. It is not clear just what sort of relationship this might be. Certainly the amphipods do not seem to irritate the anemone.

On one occasion a large *Anthopleura xanthogrammica* was placed in an aquarium with members of the smaller *A. elegantissima*, the latter containing amphipods. The following day amphipods were observed crawling about on the large anemone without hinderance! Whether or not this represents a lowering of specificity on the part of the amphipods because of the crowded condition of the aquarium remains to be determined.

Another feature of interest is the geographical and ecological distribution of the new species. Hand (1955, p. 60) gives the range of *Anthopleura elegantissima* as being from Alaska to Southern California. In the area of his study, from Bodega Head to Carmel, this species, "occurs as dense aggregations or as single individuals at all locations along the rocky open coast. It also penetrates deeply into bays, and in such situations large single individuals are more common than aggregations." With this in mind, it might be asked whether *Allogaussia* has a distribution similar to that of its host. An answer to this question cannot be given at present. That *Allogaussia recondita* does not occur in all areas where *Anthopleura elegantissima* thrives is evident from its very limited, almost "colonylike" distribution at Moss Beach. At this locality amphipods could be found only in those anemones on the "Sand Rocks," the numbers of specimens per anemone becoming less as the distance from these rocks increased, until, finally, no amphipods at all could be found in *Anthopleura*. Such a condition may be seasonal, may vary from year to year, or it may represent specific ecological factors not evident at this time.

Surprisingly enough, the association here described is not unique. In 1925, Elmhirst briefly described a similar relationship in England between the gammarid *Metopa solsbergi* and the anemone *Actinoloba dianthus* (now *Metridium senile*). The anemones of this association were found living on pilings 12 or 15 feet below low water. The amphipods were seen to move about over the surface of the anemone and to enter and leave the stomodaeum unharmed. "*Tealia crassicornis* ate them without hesitation, *Actinia equina* took them slowly, but after some minutes the *Metopa* generally emerged again" (Elmhirst, 1925, p. 150). Elmhirst mentions that the slime of *Actinoloba* seems to be the natural food of the amphipod.

Edmondson (1951) described *Elasmopus calliactis* which lives in association with an anemone, *Calliactus armillatas*, taken from depths of about 16 fathoms off the coast of Oahu in the Hawaiian Islands. The anemone is found upon shells inhabited by a hermit crab and Edmondson states (p. 189) that "While its usual host is the sea anemone, the amphipod harmonizes in color equally well with the hermit crab and no doubt has freedom of movement from one organism to the other." Nothing about the association more definite than this was noted. How much similarity exists between these associations and that of *Anthopleura-Allogaussia* is not known.

The species here described is the first of

the genus to be discovered in the Pacific. The species of Schellenberg and of Barnard are described from antarctic waters or from the waters off South Georgia Island in the South Atlantic. Moreover, the new species is the first to be found in the littoral zone. All previous species were brought up from deep water in dredges or trawls.

ACKNOWLEDGMENTS

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*The ultimate aim of those who are devoted to science is to penetrate beyond the phenomena observed on the surface to the ultimate causes, and to reduce the whole . . . to a simple deductive system of mechanics, in which the phenomena observed shall be shown to flow naturally from the few simple laws that underlie the structure of the universe.*—CLEVELAND ABBE.

HERPETOLOGY.—*Another new species of* Eleutherodactylus (*Amphibia: Leptodactylidae*) *from western Cuba.* Albert Schwartz, Albright College, Reading, Pa. (Communicated by Herbert Friedmann.)

Three papers (Schwartz, 1957, 1958a, 1958b) on collections of *Eleutherodactylus* from Pinar del Río Province, Cuba, have already been published. These, as well as the present description, are based upon collections made during the summer of 1957 under a National Science Foundation grant; collections were also made during the Christmas holiday seasons of 1956–57 and 1957–58. Much time has spent collecting amphibians and reptiles in the westernmost province of Pinar del Río; that this area has been but poorly worked previously is attested by the number of new forms which have been encountered there; to this increasingly large list of new species, another new small leptodactylid frog is herewith added.

On August 30 and 31, 1957, two visits were made to Soroa, Pinar del Río Province, in the company of Richard Thomas. Because of previously heavy precipitation, the area in general was very wet, and the Río Manantiales, which forms a scenic waterfall at Soroa, was at a high level. Collecting at night in the gorge along the river yielded a small series of frogs which I regarded as a new form at the time of collection. During the Christmas holiday season of 1957–58, opportunity was given to return to Soroa in the company of Edwin B. Erickson, Willard M. Stitzell, and George R. Zug. On this second visit, although the weather conditions were not so rainy as in August, we were able to secure another series of this small frog. I wish to thank these men who have helped me collect in the Soroa area; without their invaluable assistance such an adequate series of these little frogs would not have been obtained. I take great pleasure in naming this form after George R. Zug, whose interest, genial cooperation, and hearty assistance in the field have aided me immeasurably in my work, as—

**Eleutherodactylus zugi, n. sp.**

*Type.*—American Museum of Natural History (A.M.N.H.) no. 60938, from Soroa, Pinar del Río Province, Cuba, one of a series taken by Edwin B. Erickson, Albert Schwartz, Willard M. Stitzell, and George R. Zug, on January 1, 1958. Original number 4903.

*Paratypes.*—A.M.N.H. nos. 60919–27, Soroa, Pinar del Río Province, A. Schwartz, R. Thomas, August 30, 1957; A.M.N.H. nos. 60928–35, Soroa, Pinar del Río Province, A. Schwartz, R. Thomas, August 31, 1957; A.M.N.H. nos. 60936–37, 60939–49, same data as type.

*Distribution.*—Known only from the gorge of the waterfall of the Río Manatiales at Soroa, Pinar del Río Province.

*Diagnosis.*—An *Eleutherodactylus* characterized by small size, warty dorsum, rosy suffusion on thighs, a single transverse brown band across center of thigh, long and straight vomerine series, and usually an orange or yellow striped dorsum.

*Description of type.*—An adult female, with the following measurements (all measurements in millimeters): snout-vent length, 18.9; head length (snout to posterior border of tympanum), 6.8; greatest width of head, 6.2; longitudinal diameter of eye, 2.2; longitudinal diameter of tympanum, 1.4; naris to anterior corner of eye, 2.0; femur, 7.8; tibia, 8.7; length of fourth toe, 6.9. Head slightly narrower than distance from snout to posterior border of tympanum; snout rather acute with nares relatively inconspicuous at anterior end of canthus rostralis; diameter of eye about equal to distance from naris to anterior corner of eye; interorbital space 2.3, about equal to diameter of eye; diameter of tympanum less than diameter of eye, distance from tympanum to eye about equal to diameter of tympanum. Digital discs present, poorly developed on digits 1 and 2, that on digit 3 the largest and equal to about one quarter size of tympanum. Fingers short, unwebbed, 3-4-2-1 in order of decreasing length; subarticular tubercles well developed. Toes short, unwebbed, 4-3-5-2-1 in order of decreasing length. Heels do not touch when legs are held with femora at right angles to body axis. Dorsum irregularly warty, with a raised median middorsal line from snout to above vent; upper eyelids somewhat warty, but not distinctly so. Throat and venter smooth; belly disc feebly developed. Posterior surface of thighs covered with smooth, flattened, pavementlike granules. Tongue

elongate oval, free behind, its greatest width about half that of floor of mouth. Vomerine teeth in two long, slightly bowed, series, extending from the level of the choanae, and almost meeting at the midline of the roof of the mouth.

FIG. 1.—*Eleutherodactylus zugi*, n.sp., paratype, A.M.N.H. no. 60922, adult female, snout-vent length 18.0 mm. Photograph taken by William H. Gehrmann, Jr., in field.

*Coloration of type.*—Dorsum and sides chocolate brown; beginning on the snout, a pale orange line extends along the canthus rostralis, over the upper eyelid (where it is narrow but present), and along the dorsolateral area to end at the sides of the groin at the insertion of the hindlimbs; this pale orange line widens on the sides and meets the creamy white ventral coloration at the groin. The brown lateral color begins below the pale line on the snout, extends over the lores, tympanic region, and insertion of the forelimb, but is invaded by the ventral white color midway between fore- and hindlimbs, giving a mottled or blotched effect. Forelimbs brown, with the brachium pale orange. Thighs brown with a distinct and prominent rosy suffusion, especially prominent on their anterior faces, but present also on the dorsal surface. A truncate, brown triangle, its apex at the vent, extends ventrally over the posterior face of the thighs as far as the ventral color. A single brown transverse band across the center of the thigh and a small brown transverse band just above the knee; crus pinkish with a pair of transverse brown bands, the more distal of which is the wider, and which, when the legs are held in the flexed position, continues the transverse band of the thigh. Feet dull brown, irregularly blotched with darker. Venter pearly white, with brown chromatophores scattered on all ventral surfaces except the median portion of the belly. The lower jaw is flecked with brown and white.

*Variation.*—The series of paratypes includes eleven males and nineteen females, of which all but one female appear to be mature. In adult males, the testes are jet black and prominent among the viscera; in fully adult females the oviducts are large and convoluted, and two are gravid. The means and observed ranges of the males are: snout-vent length, 15.0 (12.1–16.8); head length, 5.6 (4.6–6.4); greatest width of head, 5.2 (4.2–5.8); diameter of eye, 2.0 (1.7–2.2); diameter of tympanum, 1.3 (0.9–1.5); naris to eye, 1.6 (1.2–1.8); femur, 6.8 (6.0–7.5); tibia, 7.5 (6.2–8.4); length of fourth toe, 6.7 (5.4–7.7). The measurements of all females (type and paratypes) are: snout-vent length, 16.7 (12.7–19.2); head length, 6.1 (4.8–7.1); greatest width of head, 5.9 (4.5–6.8); diameter of eye, 2.1 (1.6–2.9); diameter of tympanum, 1.3 (0.9–1.8); naris to eye, 1.7 (1.2–2.5); femur, 7.3 (5.5–8.5); tibia, 7.6 (6.7–8.9); length of fourth toe, 7.2 (5.6–7.9). From these data it can be observed that females reach a larger size than males, but this difference is not so striking as may be noted in other species of Cuban *Eleutherodactylus*, as for example *cuneatus* (see Schwartz and Ogren, 1956, p. 96). When males and females of comparable size are studied, females are observed to have larger tympana than males.

Structurally, the paratypes agree well with the type with the exception of the degree of wartiness on the dorsum and sides. In these characters, the type demonstrates a less warty condition than many of the paratypes; this is undoubtedly due to the method of preservation. In specimens which were less fully injected with formalin at the time of preservation, the dorsum, sides, and lateral portions of the belly are very warty, and the dorsal surface of the limbs are likewise studded with scattered tubercles, arranged at random. The vomerine teeth series are always relatively long and slightly arched; they may begin within the interior margin of choanae, or not extend quite so far medially as in the type.

The series of *E. zugi* shows three basic color patterns. The first pattern, of which the type is an example, shows a dark brown to tan middorsal zone, bounded on each side by a broad yellow or orange dorsolateral stripe, ending on the sides just anterior to the hindlimb insertion (see

Fig. 1). To this category may be assigned 5 males and 10 females, as well as the type which is also a female. In some of these individuals, the middorsal zone is mottled with yellowish or white, and one male (A.M.N.H. no. 60941) has the posterior portion of the dorsal band transversely striped in a condition reminiscent of that of *E. pinarensis* Dunn. In some of this lot, the snout is light tan, lighter than the dark brown dorsum, but only poorly delimited by a brownish to black interocular line, bar, or even elongate triangle, which extends posteriorly along the dorsal midline. In one individual (A.M.N.H. no. 60947) there is a pair of pink dots just posterior to the eye in the dorsal band. In frogs which have the dorsal band more lightly pigmented, the dorsolateral bands are outlined above and below with black.

The second pattern involves the suppression of the broad dorsolateral orange bands, and the occurrence of a pair of dorsolateral stripes which end *dorsally*, rather than *laterally*, above the insertion of the hindlimbs. To this group belong five males and six females. That these dorsolateral lines are different from the dorsolateral bands described for the preceding pattern is demonstrated by two specimens (A.M.N.H. nos. 60921, a male, and 60920, a female), both of which show vestiges of the lines posteriorly, but possess the broad dorsolateral bands in addition. All males and two females possessing the second dorsal pattern also demonstrate a fine pale middorsal hairline from the sacral region to just above the vent, where it divides, sending a pale red branch along the concealed face of the thigh, where it becomes obscured in the pattern of that member. This feature is only barely indicated or absent in all frogs showing dorsal pattern one. Four females showing the second pattern have either one or two pairs of pink dots in the dorsal band, one pair behind the eyes and another in the scapular region.

The third scheme of dorsal coloration is that of a mottled dorsum with no indications of either dorsolateral bands or lines, the entire dorsum having a mottled or dotted appearance. To this group belong one male and three females. One female has two pairs of pink dots in the usual position. No specimen of this lot has a dorsal pale hairline or pale lines on the inner surface of the thighs. A gray or black interocular mark is present in all, although it may be not so obvious (A.M.N.H. no. 60944) or may blend into the dorsal dark coloration (A.M.N.H. no. 60932).

The hindlimb markings remain remarkably constant in all individuals, despite the variation in dorsal pattern. These markings are those described for the type. The median transverse thigh band, and the more distal of the crural bands are always present; although the thigh band may be reduced or obsolescent, it is always present. In addition, many frogs show a brown transverse band on the pes, which, when the foot is flexed, continues the transverse marking from the thigh onto the crus and thence the pes. In some individuals, the more proximal of the crural bands noted in the type is completely absent. In all specimens, the rosy suffusion on the thighs and crus was well developed in life.

*Comparisons.*—*E. zugi* is a representative of the *ricordi* group as defined by Dunn (1926, p. 210). To this group 13 forms are now assigned. The present species does not require comparison with members of the *auriculatus*, *varleyi*, *dimidiatus*, and *symingtoni* groups because of its distinctive structural characters (for characteristics of these groups see Dunn, *op. cit.*, Schwartz, 1957 and 1958a). Of the members of the *ricordi* group, comparison with *ricordi* and its subspecies, *pinarensis*, *greyi*, *brevipalmatus*, *sierramaestrae*, *turquinensis*, *cuneatus*, and *etheridgei* is unnecessary; all these species are larger than *zugi* (although male *r. planirostris* and possibly *r. casparii* may be as small as adult female *zugi*, and male *etheridgei* are just slightly larger than male *zugi* and within the observed range of female *zugi*) and none possesses the rosy red suffusion on the hind legs nor has the single transverse brown band on the thigh and crus.

The only species of the *ricordi* group with which comparison is necessary are *E. gundlachi* Schmidt and *E. atkinsi* Dunn and its subspecies. The former species is known only from various localities in the Sierra Maestra and near Guantánamo, both in Oriente Province. *E. zugi* differs from *E. gundlachi* in smaller size; Alayo (1955, p. 8) gives a length of 22 mm. for *gundlachi* and I have examined a specimen (United States National Museum No. 118210) with a snout-vent length of 25.2 mm. Both *zugi* and *gundlachi* have red on the hindlimbs; the *gundlachi* hindlimb pattern involves a red anterior and posterior face to the thigh, with a distinct dorsal longitudinal brownish area from the groin to the outer face of the knee; in *zugi*, this dorsal longitudinal thigh

band is absent, the entire dorsal face of the thigh being pigmented and there being no definite, clearly defined area. *E. gundlachi*, just as *zugi*, possesses transverse thigh bands, regularly spaced; in *gundlachi* these number three, in *zugi*, only two with the much less prominent one at the knee. *E. gundlachi* likewise has two crural transverse bands, matching the two innermost thigh bands, in contrast to the one crural band in *zugi*. Structurally, *gundlachi* differs from *zugi* in the feeble development of digital discs (these are small but in harmony with the small size of the frog in *zugi*), much longer hindlimbs, and in having the dorsum extremely rugose with the warts arranged in longitudinal series (see Barbour and Ramsden, pl. 6, fig. 1, as *E. plicatus*), a condition not observed in the new species. It is possible that *zugi* is a western counterpart of the eastern *gundlachi*, but the differences are so pronounced, that I have no hesitancy in regarding *zugi* as a species distinct from *gundlachi*; the similarity between the two species rests almost solely on the red thighs of both forms.

*E. atkinsi atkinsi* Dunn and *E. atkinsi orientalis* Barbour and Shreve are members of the *ricordi* group, and also possess red in the groin and on the hindlimbs. Both these subspecies reach a much larger size than *zugi*; Dunn (1925, p. 166) gives lengths of 31 mm for the type, a male, and 39 mm for a female of *a. atkinsi*, and Barbour and Shreve (1937, p. 383) give maximum length measurements of *a. orientalis* as 43 mm. *E. atkinsi* lacks digital discs, whereas *zugi* possess them. In *atkinsi*, the red coloration occurs over the entire thigh, and there are no transverse dark bands on the thigh as in *zugi*. The nominate race in addition possesses a large and well defined black groin blotch which may extend onto the most proximal part of the thigh; this blotch is reduced or absent in the subspecies *orientalis*. Such blotching does not occur in any of the specimens of *zugi*. Dorsal warting is poorly developed in *atkinsi* except along the dorsolateral line; although *zugi* is warty dorsally, there is no increased development of these warts along the dorsolateral line. The scheme of coloration of both *atkinsi* and *zugi* (in the dorsally banded or lined phases) is superficially similar, but *atkinsi* regularly has a pale snout set off from the darker dorsal area by a discrete interocular bar or band, as well as a dusky scapular W and a sacral dusky marking. No *zugi* have a sharply differentiated pale snout (although as noted above, the snout may be poorly delimited in some specimens), nor do they have a scapular W or a sacral marking of any sort. Certainly no difficulty will result in distinguishing adult *atkinsi* from adult *zugi*; young *atkinsi* within the size range of adult *zugi* can be distinguished by the presence of a black groin spot and absence of any transverse thigh banding. Remarkably, at Soroa, of hundreds of *Eleutherodactylus* collected, no *E. a. atkinsi* (the subspecies known to occur in Pinar del Río Province) have been taken, despite excellent weather conditions and suitable habitat.

One other Cuban species of *Eleutherodactylus* is known to have red in the groin; this species is *E. emiliae* Dunn. No confusion between *emiliae* and *zugi* should occur; the former is known only from the Sierra de Trinidad in Las Villas Province, is a member of the *dimidiatus* group having a black cheek patch, feebly developed discs, and smooth skin, and is larger. *E. emiliae* is also microhylid in appearance, and thus is quite different from *zugi*.

*Remarks.*—The series of *E. zugi* was taken as the result of three visits to Soroa. Soroa lies in the Sierra del Rosario subregion (see Marrero, 1951, pp. 416 *et seq.*), an area of great relief owing to the montane mass of the Sierra del Rosario; the highest peak in this mountain range is Pan de Guajaibón, with an elevation of 728 meters; the elevation at Soroa is much less than this, probably no more than 300 meters. This subregion receives more than 150 cm of rainfall annually, and is exceeded in Cuba only by the more western but adjoining Sierra de los Organos. Both areas appear to be especially rich in amphibians. At the time of our first visit to Soroa in August, 1957, the area was very wet, and the Río Manantiales was in flood with much water coming over the falls in the gorge. The spray from the falls had moistened the ground, rocks, and vegetation in the immediate vicinity, and the specimens of *E. zugi* were taken on the exposed leaves of shrubs between 2 inches and 4 feet above the ground. These leaves were very wet with droplets of water from the spray of the waterfall.

At the time of our second visit in January, 1958, conditions were less wet, and the river was not in flood. Specimens of *E. zugi* were taken during the day under palm trash and other debris on the narrow flood plain in the gorge, no farther back from the river than 30 feet. Con-

ditions under the trash were not especially wet. At night, these frogs were taken on moist rocks as much as four feet above the ground surface, and none was captured on leaves as in August. Despite a moderate but continued rain beginning in the early afternoon of January 1, the dense forest canopy prevented the drenching of the understory of shrubs and herbs upon which we had collected *zugi* in August. It appears that *E. zugi* utilizes ground cover such as debris and trash during the day, and at night ventures forth to forage from low plants (if weather conditions are wet) or from rocks (if weather conditions are drier). No specimens of *E. zugi* have been collected outside of the gorge of the Río Manantiales; it may be that the gorge presents the optimum conditions of humidity which this frog requires, and that it is unable to persist in the deciduous forest above the gorge. In the gorge also we have taken *E. eileenae*, *E. cuneatus*, *E. d. amelasma*, and *E. r. planirostris*. Above the gorge in the deciduous forest these four species also occur, although *eileenae* is distinctly less abundant and *ricordi* more abundant than in the gorge.

Despite much collecting in other parts of Pinar del Río, *E. zugi* has not been taken elsewhere. It should be looked for along any of the streams cutting through the montane masses of the Sierra de los Organos and the Sierra del Rosario. Its complete distribution will become known only by searching for it in the most humid habitats in the mountanous areas.

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*Language is not an abstract construction of the learned, or of dictionary-makers, but is something arising out of the work, needs, ties, joys, affections, tastes, of long generations of humanity, and has its bases broad and low, close to the ground.*—WALT WHITMAN.

# PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

## GEOLOGICAL SOCIETY

### 768TH MEETING

The 768th meeting of the Society was held at the Cosmos Club, January 9, 1957, Vice-President PAUL AVERITT presiding.

*Program.*—K. H. WEDEPOHL: *Tertiary basalts in western Germany.*

H. G. THOMASSON: *Ground-water problems in the Southwest.*

G. A. COOPER: *Evolution of the spiny brachiopods.*

### 769TH MEETING

The 769th meeting of the Society was held at the Cosmos Club, January 23, 1957, Vice-President PAUL AVERITT presiding.

*Communication.*—FRANK SHAIRER: *Memorial to N. L. BOWEN.*

*Program.*—K. C. DUNHAM: *The mineralization of the English Pennines.*

P. C. BATEMAN: *Characteristics of some eastern Sierra Nevada granites.* About 500 square miles in the eastern part of the Sierra Nevada batholith near Bishop, Calif., was mapped geologically. The batholith there is a mosaic of discrete intrusive masses of granitic rock, which are in sharp contact with one another or are separated by thin septa (screens) of metamorphic rock or mafic igneous rock. Large pendants and small inclusions of metamorphosed sedimentary and volcanic rocks are present locally. The granitic masses or plutons have been divided into 10 formations on the basis of composition, texture, and intrusive relations. These formations include one of quartz diorite, one of granite, three of quartz monzonite, and five of granodiorite. The following features taken together indicate that the major part of the granitic rocks are magmatic:

1. Contacts of individual plutons with each other and with older rocks are sharp, clean, and regular.
2. Finer grained rock is present in the marginal parts and apophyses of some plutons.
3. The walls of aschistic dikes marginal to some plutons are dilated.
4. The geometry of some dislocations of the wall rocks suggest strongly that they were caused by the forcible emplacement of magma. In one place a dislocation of three miles seems clearly attributable to forcible intrusion, and in another a dislocation of 8 miles seems probable. Intrusive breccias are present locally.
5. The internal foliation in the margins of plutons parallels external contacts.
6. Granitization and assimilation effects are confined to amphibolites and other wall rocks that consist chiefly of minerals earlier in Bowen's reaction series than those crystallized in the granitic rocks. The effects are in accord with theoretical expectations of reactions between granitic magma and wall rocks.
7. The metamorphic grade of the wall rocks and of inclusions is that of the amphibolite facies, which is in accord with the temperatures believed to exist in nonsuperheated granitic magmas.
8. Variations in the compositions of the granitic rocks are in accord with variations predicted from experimental studies of melts.

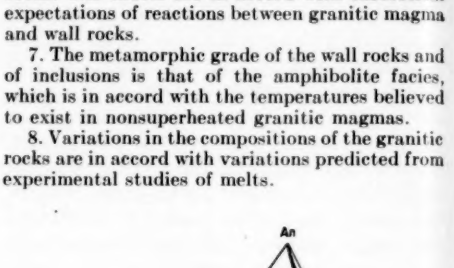


FIG. 1.—Quartz-orthoclase-albite-anorthite tetrahedron showing plot of norms on bisecting plane Ab-An-Qu plus Or.

Two kinds of analytical data were obtained, (1) limited chemical data and (2) extensive modal data. Chemical analyses of representative specimens of each of the granitic formations were calculated to CIPW norms. Plotted on a quartz-orthoclase-plagioclase triangular diagram the norms fall close to a straight line that trends from the plagioclase corner toward the experimentally determined ternary eutectic near the center of the diagram. Plotted within a quartz-orthoclase-albite-anorthite tetrahedron the norms fall close to a bisecting plane that passes through the albite

and anorthite corners and bisects the quartz-orthoclase join (Fig. 1). The norms plot on this plane along a curved line that runs from near the center away from anorthite. The line bends progressively with distance from anorthite toward the quartz-orthoclase join and is convex toward albite. This curved line is close to the theoretical path of the liquidus. At about 10 percent of anorthite the line bends sharply back toward albite, probably along the experimentally established join between quartz and the feldspars.

Modal data for each pluton and for each group of plutons assigned to a formation are plotted on a quartz-K feldspar-plagioclase triangular diagram. These data generally are in accord with the plot of norms on the same diagram, but most plutons exhibit considerable scatter, and the field for some plutons is systematically displaced from the straight line path exhibited by the norms. Some scatter results from sampling deficiencies, but some appears to represent a zonation in composition from margin to core or along or across the strike of plutons. Systematic dislocations of the fields of modes of plutons from the line defined by norms results from the crystallization of minerals, especially mica, not represented in the diagram.

Averages of the modal content of plagioclase, biotite, and hornblende of each granitic formation plotted in a binary diagram against quartz plus K-feldspar show that plagioclase, biotite, and hornblende decrease regularly with increase in quartz plus K-feldspar. Hornblende is about 4 percent less abundant in most rocks than biotite and is not present in rocks with more than 55 percent of quartz plus K-feldspar—the approximate boundary between granodiorite and quartz monzonite.

### 770TH MEETING

The 770th meeting of the Society was held at the Cosmos Club, February 13, 1957, Vice-President PAUL AVERITT presiding.

A memorial to WILLIAM F. FOSHAG was read by GEORGE SWITZER.

*Program.*—J. T. HACK: *Erosive work of great rainfalls or gully washers in the Appalachians.*

W. J. DEMPSEY: *Use of aeromagnetic data to determine regional basement topography.*

DOUGLAS BALL and A. S. WINER: *Brandywine Structure, and underground natural gas storage for Washington, D. C.* The Brandywine Structure is a closed anticline in Prince Georges County, Md., about 10 miles from Washington, D. C. The Washington Gas Light Co. found the anticline in its search for underground gas storage for Washington. On the basement and in the sediments immediately above, the anticline has about 150 feet of closure and covers about 6,000 acres. It is long and narrow, about 10 by 2 miles. Its axis is northeast-southwest, parallel to the strike of the Atlantic Coastal Plain Basin.

Sedimentary rocks of the area include Pleistocene, Tertiary, and Cretaceous formations and an inlier or updip pinchout of indurated, poorly sorted, arkosic sediments of Triassic age. The unexposed basement is composed of metamorphic Paleozoic or Precambrian rocks similar to those of the nearby Piedmont.

Starting with a study of the markers described in water well logs, the company used subsurface information, gravity, magnetics, slim-hole drilling, big-diameter coring, and geophysical logging to map important beds of the anticline. The closure, depth, and a combination of reservoir and cap rock in the Patuxent formation, the oldest Cretaceous formation in the area, appear to make the anticline favorable for gas storage.

### 771ST MEETING

The 771st meeting of the Society was held at the Cosmos Club, February 27, 1957, Vice-President PAUL AVERITT presiding.

*Informal communications.*—M. G. WOLMAN described an experimental flume for sedimentation studies.

W. P. WOODRING discussed the first successful oil well in Central America (Costa Rica-Panama).

*Program.*—T. P. THAYER: *Some relations of later Tertiary volcanology and structure in eastern Oregon.* Along the southern edge of the Columbia Plateau and the northern edge of the Basin and Range province variations in the Miocene volcanic rocks seem closely related to patterns of deformation.

The dominant structural feature of the region is the east-west Aldrich-Strawberry Mountain range, which is partly an asymmetric anticline with the north limb vertical, and partly a south-dipping fault block. To the north, the uniform basalt flows of the Columbia Plateau were fed from fissures and deformed by east-west folds accompanied by subordinate faulting. To the south, the Miocene volcanic rocks range from olivine basalt to rhyolite, were erupted from volcanoes, and were broken by northwest-trend-

ing faults. At a few places in the volcanic border zone, plateau basalts are intercalated with basaltic andesite and rhyolite; elsewhere correlation of the two lava facies is uncertain. In the zone of structural transition, 40 to 50 miles wide, the northwest-trending faults merge with the westerly trending folds in ways indicating contemporaneity. The correlations between volcanism and deformation are believed to indicate a common control by variations in the crust and subcrustal layers.

J. R. VALLENTYNE: *Paleobiochemistry.* The preservation of organic compounds (other than amino acids) under geologic conditions was reviewed and discussed. Under the heading of carbohydrates, reference is made to: (1) the occurrence of free sugars in extracts of lake sediments (1954→); (2) the preservation of celluloses and hemicelluloses in Tertiary lignites (1922→); and (3) Aberhalden's (1933) demonstration of chitin in Eocene beetles. Treibs' (1934→) discovery of porphyrins in coals, oil shales, crude oil and guano is brought into focus with more recent work on sedimentary porphyrins. The nature of chlorophyll degradation products in recent sediments (1939→) is briefly mentioned.

Steriods (as a class) have been identified in both recent and fossil sedimentary materials (1938→), but the exact identities have not been determined. Carotenoids (1930→), purines and pyrimidines (1917→) have been isolated from recent muds. Studies of their preservation in older sedimentary rocks have not been complete enough to determine whether or not they are preserved there.

H. A. MEYERHOFF: *Evolution of Appalachian drainage: a reinterpretation from geologic evidence.* Theories of origin for southeast-flowing master streams have all been based on the assumption that drainage flowed northwest following the Appalachian orogeny and that the direction of flow had to be reversed. One hypothesis (Thompson) has reversal taking place progressively by headward migration of the divide and by piracy; one (Davis) utilizes tilting of an assumed Cretaceous peneplane; and the most widely accepted (Johnson) invokes regional superposition from a Cretaceous coastal plain cover, since removed.

The basic assumption of a need for reversal is contradicted by every line of geological evidence including: (1) The presence of fossiliferous Paleozoic pebbles in the Lower Cretaceous Raritan and Potomac formations, as well as in younger coastal plain formations, demonstrates that drainage from the Appalachian fold belt was already oriented from northwest to southeast at the beginning of Cretaceous time. This fact invalidates the theory of regional superposition. (2) Lithologic components of all Upper Triassic formations, including the Stockton, show that the dominant source of supply was from the northwest, that structurally controlled master streams from the fold belt were already well established and could have functioned in a parental role to modern drainage. (3) Paleozoic stratigraphy and Appalachian structures demonstrate that the Adirondack and Nittany uplifts were topographically higher than structural sags in the Precambrian of Blue Ridge and Reading Prong, hence major drainage would have moved in a southeasterly direction immediately following Appalachian orogeny. (4) Windgaps and watergaps in the fold belt are related to local superposition from higher lithologic overburdens of Paleozoic age. (5) Marginal superposition from a Miocene (?) marine overlap extended inland to Middletown in Connecticut, Sparkhill gap in southeastern New York, and the Watchung range in New Jersey.

## 772D MEETING

The 772d meeting of the Society was held at the Cosmos Club, March 13, 1957, Vice-President PAUL AVERITT presiding.

*Informal communications.*—L. B. LEOPOLD discussed meanders of the Atlantic gulf streams.

MEYER RUBIN: *Radiocarbon age determination of a Pleistocene section near Scranton, Iowa.* A new spectacular Pleistocene section was uncovered during relocation of U. S. Highway 30, 4 miles east of the town of Scranton, Greene County, Iowa, in a cut across the east valley slope of the Raccoon River. The section was measured by Robert V. Ruhe, Soil Conservation Service, U. S. Department of Agriculture, and consists of 18 feet of Cary till at the top, underlain by 17 feet of silt, and 13 feet of early Wisconsin till at the base. The silt contains tree stumps rooted in place at various horizons. The trunks of the trees that are rooted in the upper zone of the silt are bent toward the south. As the outer boundary of the Cary in this Des Moines lobe is only 25 miles to the south, the dating of the trees gives the time of ice arrival at this near-climax position, and therefore

yields a more accurate Cary maximum date than hitherto possible.

Three samples of logs from this and another site 2½ miles north of Scranton were submitted by Ruhe and dated by the carbon-14 method at the U. S. Geological Survey laboratory. The results in years are: W-512, 14,470 ± 400; W-513, 13,820 ± 400; and W-517, 13,910 ± 400. The average of approximately 14,000 years can be considered the climax of the Cary substage in this lobe.

F. N. JOHNSTON reviewed a book titled *morphologie littorale et sous-marine*, published in Paris, Universitaires de France, 1954.

*Program.*—D. B. STEWART: *Some feldspar problems.* Simple X-ray and optical methods for determining the composition and thermal state of alkali feldspar with less than 5 percent An and plagioclase with less than 5 percent Or are reviewed. Inability to determine the ternary composition of a feldspar without a chemical analysis is discussed, and the need for carefully studied natural ternary feldspars is emphasized. Factors such as temperature, pressure, composition, and time that influence the relations between pairs of feldspars from the same rock are discussed. One experimental method of evaluating these variables with isothermal isobaric sections is demonstrated.

E. M. IRVING: *Regional geology of the Philippines.*

R. B. NEUMAN and A. R. PALMER: *Critique of Eocambrian and Infracambrian.*

### 773D MEETING

The 773d meeting of the Society was held at the Cosmos Club, March 27, 1957, President W. D. JOHNSTON, JR., presiding.

*Informal communications.*—W. D. JOHNSTON, JR., discussed some recent geologic meetings in Europe and Asia.

Z. S. ALTSCHULER described and illustrated some geologic features of the Dead Sea Rift Valley and Negev area, Israel and Jordan.

*Program.*—ISIDORE ADLER: *Some applications of X-ray fluorescent spectroscopy to mineralogical problems.* A curved-crystal reflecting spectrometer of the type described by Birks and Brooks of the Naval Research Laboratories, but adapted for use in mineralogical studies, has been built in the Geological Survey. It has been successfully applied to the analysis of tiny crystals, zones in minerals, and individual grains in mixed-mineral specimens such as thin or polished sections, or grains or areas about 0.5 mm in diameter, X-ray diffraction spindles, and small samples of powder weighing a fraction of a milligram have also been analyzed without any loss or alteration of the sample. Of great value in thin- and polished-section work is the fact that this technique can be used to analyze selected areas without mutilating the specimen by digging out grains.

A modification of the curved-crystal spectrometer has made it possible to traverse a standard polished section in synchronization with a recorder, automatically plotting the distribution of various elements along a selected line. This method was applied, for example, to a polished section containing a central core of pyrite intergrown with and surrounded by a marcasite-like mineral. Chemical analysis of a concentrate of these these two minerals gave selenium, cobalt, and iron as major constitutents. A clear relationship between the cobalt, selenium, and iron was established by the X-ray method, identifying the second mineral as an intermediate member of the $FeSe_2$-$CoSe_2$ series.

R. G. SCHMIDT: *Titaniferous sedimentary rocks in the Cuyuna district, Minnesota.*

G. E. ANDREASEN and ISIDORE ZIETZ: *Limiting parameters in the magnetic interpretation of a geologic structure.* A prominent aeromagnetic anomaly in Randolph County, Ind., suggests the existence of a dikelike structure within the Precambrian basement rocks. Because of the ambiguity inherent in magnetic interpretation, a unique solution for the parameters involved (the depth of burial, the geometric configuration, and magnetic susceptibility of the anomaly-producing mass) is impossible. However, if one of the parameters is known it is sometimes possible to indicate a range of plausible values for each of the remaining parameters.

The depth to the surface of the Precambrian rocks in Randolph County is known from drill-hole data to be about 3,000 feet. With the depth of burial known, limits need be set only on the thicknesses, angle of dip, and susceptibility contrast of the assumed dike. The limits are determined by a graphical method. Theoretical anomalies over the postulated dike are computed for different dike thickness, angles of dip, and susceptibility contrasts. The computed profiles are then fitted to an observed magnetic profile flown at right angles to the strike of the feature. Numerical values for the "goodness of fit" are

calculated, using the statistical method of sums of squares.

Two plots, one for the index of goodness of fit and the other for susceptibility as functions of dip angle and dike thickness, are made to show graphically the interdependence of the variables and the plausible range of each. The contoured maps for the goodness of fit and the susceptibility contrast show that the range of best fit is between dip angles of 35° and 50° and dike thicknesses of 1,000 to 4,000 feet. The contoured map for the susceptibility contrast, translated into percentage of magnetite, shows this parameter to be independent of the dip angle.

### 774TH MEETING

The 774th meeting of the Society was held at the Cosmos Club, April 12, 1957, President W. D. JOHNSTON, JR., presiding.

*Informal communication.*—E. L. YOCHELSON: *The Recent mollusk* Neopilina.

*Program.*—W. P. WOODRING: *Geology of Barro Colorado Island, Canal Zone.*

R. C. DOUGLASS: *Significance and distribution of* Orbitolina. *Orbitolina* is a genus of the larger Foraminifera which is widely distributed in rocks of Cretaceous age. Its distribution is circum-global in a northern tropical to temperate belt. *Orbitolina* is commonly associated with calcarenites which contain large amounts of other organic debris, and many concentrations of the specimens are in or near bioherms. Analogy with living larger Foraminifera and sedimentary environments suggests the species flourished in warm shallow marine waters. Species of *Orbitolina* have been used for stratigraphic correlations of Cretaceous rocks in Europe and Southwestern Asia. Two zones can be recognized in the American Lower Cretaceous sequence.

L. C. PAKISER: *Gravity studies of structure in the earth's crust.*

### 775TH MEETING

The 775th meeting of the Society was held at the Cosmos Club, April 24, 1957, President W. D. JOHNSTON, JR., presiding.

*Informal communication.*—IRVING FRIEDMAN: *Vesiculation in glassy rocks.*

*Program.*—R. L. NACE: *Hydrology of the Snake River basalt.* The Snake River Plain is a huge structural depression in southern Idaho. The plain traditionally has been considered as a part of the Columbia Plateau Province, but it differs lithologically, structurally, and in geologic history from the Columbia Plateau Province in Oregon and Washington. The part of the plain east of Bliss, Idaho is a natural physiographic and geologic subdivision which was built up largely by basalt flows. That part of the plain may be a large graben lying between horst blocks represented by mountain complexes lying to the north and south.

The basalt floor of the plain is mantled widely by loessial sediments, and loess and other sediments occur as interflow beds beneath the surface throughout the plain. The Snake River basalt consists of hundreds of interlocking basalt flows, mostly local in their distribution and chiefly Pliocene in age.

From the mouth of Henry's Fork on the east, westward 300 miles to the mouth of the Boise River, no stream that rises in mountains to the north crosses the plain to join the Snake River, with the single exception of the Bid Wood (Malad) River. Instead, the streams end on the plain, losing their water by deep percolation and evaporation.

The Snake River Plain east of Bliss may be the largest unified ground-water reservoir on the North American continent, underlying more than 17,000 square miles of area. This part of the plain, which is the part treated in this paper, is the gathering ground for water from an area several times its own size. The average thickness of the zone of saturation probably is on the order of 1,000 feet.

The ground water from this body is discharged naturally through springs in a 40-mile reach of the valley of the Snake River between Milner and Bliss. The spring openings lie at all levels from that of the river to several hundred feet above, and the discharge points are controlled by geologic factors which have not been thoroughly studied. The aggregate average rate of discharge of water from the springs is more than 5,000 cfs and amounts to about 4,000,000 ac-ft per year.

Within the historic period since irrigation began on the plain, the volume of water discharged from the springs has increased at least 25 percent. The increase represents new recharge by deep seepage from farm land that is irrigated with surface water from the Snake River.

Nearly all water available from the Snake River is appropriated, and further development will require the use of ground water, on which substantial drafts already are being made. The

hydrology of the ground-water reservoir is economically important and the plain is a fertile field for hydrologic research.

Water-bearing openings in the basalt are of numerous kinds, but only a few types are volumetrically important. All the pahoehoe flows are extensively ramified by fractures caused by cooling and contraction of the lava after it solidified. Few of these fractures are widely open, and the water-storage capacity per unit volume of rock is small; the aggregate capacity in a large mass of rock, however, is considerable. At some places, as along the arched frontal edges of the lava flows, widely open tension fractures are common. So-called pressure ridges in basalt flows also contain widely open fractures. Lava tubes in pahoehoe flows range in size from that of a pencil to voids 35 or 40 feet in diameter and scores to hundreds of feet in length. The permeability of tubes is nearly infinite.

As, or broken, blocky lava is among the most permeable of all types of rock. Talus breccia is similar.

Many voids which extend to the surface in a basalt flow are partly filled by later, overriding flows, but even the big voids are not completely filled. At depth beneath the surface, therefore, the basalt ranges from nearly impermeable to extremely permeable. Basalt rock itself has little effective permeability, but the formational permeability of many zones is quite high. Transmissibility coefficients computed from pumping-test data range from a few hundred thousand to 4.5 million gpd/ft$^2$.

Ground water in the Snake River Plain generally is unconfined. Certain water-level fluctuations and other phenomena, however, are more characteristic of artesian (confined) than of unconfined conditions. In many wells most of the drawdown from pumping occurs within a few minutes after pumping begins. Also, numerous water-bearing zones are sufficiently well confined that the water in them responds readily to earthquake shocks, and seismic-response fluctuations of water levels have been recorded at many places in the plain. Water levels in many wells also fluctuate in response to changes in atmospheric pressure. These barometric fluctuations also are characteristic of artesian conditions. Barometric fluctuations also cause movement of vast quantities of air in and out of the ground through wells that are open in the zone of saturation and through lava tubes. These movements show that there are tight layers in the zone of aeration, and the intervening permeable layers communicate freely with the atmosphere only through local openings such as wells or tubes.

Commonly, the water in a new well on the plain rises a few feet to some tens of feet above the level at which water is struck by the drill. In many cases the rock at the level of the regional water table is impermeable and water does not enter the well until the impermeable zone is passed through, after which it rises to the level of the regional water table. Where the rise is small no special nomenclatural difficulties arises. In other cases, the rise may be truly artesian. At many places, the deeper the well the higher the static water level. The general term, quasi-artesian, is applied to conditions which cannot be classed definitely as either artesian or non-artesian.

The water table has been mapped in substantial parts of the Snake River Plain, and in a very general way the maps show the direction of movement of the ground water. The configuration of the water table at many places probably is very complex, but the complexities seldom are brought out in maps, which are based on water-level measurements in relatively widely spaced wells. The maps thus are broad generalizations. The direction of movement of ground water is down the maximum hydraulic gradient. Ideally, that direction would be at right angles to the water-table contours on a map. Because the maps are extreme generalizations, however, the directions inferred from the maps are correct only in a regional sense. Through short distances or at point locations, the true direction of movement often is at an angle to the apparent direction inferred from a map.

The rate of movement of ground water through the basalt is not known. From indirect evidence the estimated rate in moderately permeable basalt is about 30 ft/day or more, but the estimate may be wrong by a factor of 10 or more.

The flow of water in the basalt may be streamlined (laminar) as conventionally inferred in sand aquifers. On the other hand, turbulence is probable at some times and places. Turbulence would cause mixing of waters from various sources.

Determination of the direction, rate, and nature of ground water flow in the basalt is extremely important for very practical reasons.

For example, where liquid-waste material, including that containing radioisotope wastes from nuclear-energy facilities, is disposed of in the ground and reaches the zone of saturation, it is important to know where the material will go, how fast it will move, and to what extent it will be diluted.

A. R. KINKEL: *Copper deposits of the Philippines.* Copper deposits of many types occur in the Philippine Islands and copper mineralization is widespread. Because of emphasis on gold mining and relatively unfavorable economic conditions for copper mining, little prospecting was done for copper until the last few years, although many copper deposits were found during the search for gold. Practically all of the limited copper production of the Philippines before World War II, and up to 1955, came from two mines, the Lepanto mine and the Hixbar mine. Several new mines began production in 1955 and other mines will begin production in 1957.

The author has compiled all the available geologic information on 92 copper mines in the Philippines. Of these, 37 are vein-form deposits, 26 are deposits of massive pyrite that contain copper, zinc, gold, and silver, 7 are disseminated copper deposits, and 22 are other types of deposits. A report on these copper deposits of the Philippines will be published by the Philippine Bureau of Mines early in 1958.

Twenty-seven thousand metric tons of copper were produced in the Republic of the Philippines in 1956, and it seems probable that the copper production of the Philippines, which in 1956 surpassed in value all other metals, will increase many fold in the next decade.

HARLEY BARNES: *Geology of a Philippine coal field.* The Philippine coalfield described in this paper is located in south-central Cebu, one of the islands in the Visayan group in the south-central part of the Philippine Archipelago. The coalfield is located in a mapped region of 230 square kilometers in the municipalities of Argao and Dalaguete. Most of the region is covered by the Carcar and Balamban limestone sequence, but an erosional window about 40 square kilometers in area exposes a sequence of older clastic rocks, limestone, and coal, here named the Argao group. The group comprises in conformable sequence the Calagasan formation, composed of conglomerate, sandstone, shale, limestone, and coal; the Butong limestone, crystalline and argillaceous limestone; and the Linut-od formation, a coal-bearing clastic sequence similar to the Calagasan. In fault contact with the Calagasan formation in the northeastern corner of the window is the Pandan formation, a sequence of slightly metamorphosed clastic rocks with interbedded flows. The Pandan formation is believed to be Cretaceous in age, the Argao group is early Miocene, and the different parts of the thick Carcar and Balamban limestone sequence may range in age from late Miocene to Recent.

The structure of the Argao-Dalaguete region reflects two distinct patterns of deformation. The older and more severely deformed rocks of the Argao group show northward-trending close folding, and westward-trending cross-faulting. Folding is relatively intense with vertical and overturned beds common. Horizontal rather than vertical displacement is dominant along the westward-trending cross-faults. From the regional viewpoint the structure of the Argao rocks exposed in the erosional window is only part of the eastern limb of a large syncline that is broken near the middle of the window by a major westward-trending fault. The younger Carcar and Balamban rocks show northeastward-trending broad folds and faults. Folding is relatively gentle and displacement by faulting is chiefly vertical. The major structure of the Carcar and Balamban rocks is the northeastward-trending anticline that arches across the entire island of Cebu in the Argao-Dalaguete region. The drainage patterns of the region reflect distinctly the structure and lithologic variations of the underlying rocks.

The region includes three important areas of coal-bearing rocks, the Bayabas-Balaas coal area in the north, and the Manlapay-Dumalan and Gransina-Mantalongon coal areas in the south. The Bayabas-Balaas area includes from two to six coal beds in the upper part of the Calagasan formation below the Butong limestone and from two to four coal beds in the lower part of the Linut-od formation above the Butong limestone, which is thin in that area. The two southern coal areas are separated from each other by a greatly thickened sequence of Butong limestone. The Manlapay-Dumalan area includes three beds of coal in the Calagasan formation below the Butong, and the Gransina-Mantalongon coal area includes from one to five beds of coal in the Linut-od formation above

the Butong. The mapped coal beds range from 35 to 400 centimeters in thickness and are generally lenticular, but one or more beds in each coal area have been traced as far as two to three kilometers. Bedding generally dips steeply westward and is overturned in the central part of the Gransina-Mantalongon area. A number of minor transverse faults cut the coal in each area. The coal in the region is both bituminous and subbituminous, but most of the samples analyzed have been of high volatile B and C bituminous rank. Estimated recoverable reserves of coal above assumed drainage levels total 2,579,000 metric tons. Estimated recoverable reserves in the first 100 meters below assumed drainage levels total 1,531,000 metric tons.

Much of the information for this talk is presented in a report prepared for the Philippine Bureau of Mines in cooperation with the United States Geological Survey under the auspices of the United States International Cooperation Administration and the Philippine Council for United States Aid. The report is Philippine Bureau of Mines Special Projects Series Publication No. 7, published in Manila, 1956, titled *Geology and coal resources of the Argao-Dalaguete region, Cebu*, by Harley Barnes, Cresencio P. Jongco, Generoso C. Lazaga, and Harold E. Vokes.

### 776TH MEETING

The 776th meeting of the Society was held in the Cosmos Club, May 8, 1957, President W. D. JOHNSTON, JR., presiding.

*Informal communication.*—I. G. SOHN: *Ostracods from the Morrison formation and Inyan Kara group of the Black Hills.*

*Program.*—ELLIS L. YOCHELSON: *The Lower Ordovician gastropod* Ceratopea. *Ceratopea* is widespread in areas of Lower Ordovician rocks in the southern Appalachian Mountains, Ozark Plateau, Okla., and Texas. It is a guide fossil that has had much stratigraphic usefulness in the past, though details on the ranges of the several species have never been published. The specimens commonly found are the opercula, unusually thickened, paucispiral forms, having a clawlike or triangular shape. The operculа belong to low-spired pleurotomarian shells and four occurrences of such shells associated with opercula in the same outcrop, have been found during the past 50 years. The shells suggest that the genus is monophyletic, though this conclusion must remain tentative until shells of other species currently known only from their opercula are found.

ISIDORE ZIETZ: *How significant can a figure be?*

IRVING FRIEDMAN and R. L. SMITH: *The origin of water in some volcanic glasses.* The deuterium-hydrogen composition (relative to Lake Michigan water = 0.0) of water extracted from coexisting perlite and obsidian from 11 different localities was determined. The obsidians generally have a water content of from 0.08 to 0.35 percent by weight, with two samples from near Olancha, California, reaching 0.98 percent; and a relative deuterium concentration of from −4.6 to −11.0 percent. The coexisting perlite contains from 2.0 to 3.9 percent of water with a relative deuterium concentration of −3.2 to −13.8 percent. The deterium concentration in the perlites is not related to that in the enclosed obsidian. The deuterium concentration in the perlite water is related to the deuterium concentration of the modern meteoric water and contains approximately 4.0 percent less deuterium than does the ground water. The above relationships hold true for perlites from Iceland, northern New Mexico, Mojave desert, east slope of the Sierra Nevada, California coast range, Saipan, and New Zealand. As the water in the obsidian is unrelated to meteoric water, but the enclosing perlite water is related, we believe that this is evidence for the secondary hydration of obsidian to form high water content perlitic glass.

An examination of obsidian artifacts from archaeological sites shows visible hydration on specimens estimated to be 500 years old. A sample dated by $C^{14}$ as 2,000 years old shows hydration. This is proof of the hydration of obsidian at atmospheric temperature and pressure.

### 777TH MEETING

The 777th meeting of the Society was held at the Cosmos Club, October 9, 1957, President W. D. JOHNSTON, JR., presiding.

*Program.*—R. B. GUILLOU and R. G. BATES: *The correlation of airborne radioactivity data and aerial geology.* The correlation of airborne radioactivity data and areal geology in several areas of the United States is being investigated by the U. S. Geological Survey. A study of radioactivity profiles, obtained using equipment and surveying techniques developed in the search

for deposits of radioactive minerals, indicates that airborne radioactivity surveying can materially assist the field geologist by determining continuity between outcrops. In an area of Triassic rocks near Bealeton, Virginia, it is possible to differentiate between diabase and shale on the basis of their radioactivity values and an areal geologic map can be prepared from the data. Distinctive airborne radioactivity units in Marquette County, Michigan can be correlated with sedimentary rocks of Cambrian age and an area of Precambrian granite near Republic, but the areal geology of the entire area is not adequately portrayed by the radioactivity units. Airborne radioactivity surveying is of definite value in areas of low relief and residual soil such as the Piedmont, but it has limitations in areas of moderate relief or where the surficial material is not residual soil. Present investigations include study directed toward determining whether changes in surveying technique or modifications in equipment will produce data of more use from the standpoint of areal geology.

G. R. TILTON: *Are tektites out of this world?* The isotopic composition of lead from three tektites and Libyan Desert glass is compared with that from known terrestrial and extraterrestrial sources. The lead contained in the glasses is similar to modern terrestrial lead, including lead from modern oceanic sediments. The uranium, thorium, and lead concentrations were determined for one of the glasses, an australite. Evidence is given which indicates that within the last tens of millions of years differentiation of uranium, thorium, and lead occurred in the parent material of the australite. These results are difficult to explain in terms of any extraterrestrial origin involving fusion of materials from the moon, meteorites or comets, but they are readily explained if tektites are of terrestrial origin involving fusion of argillaceous sediments in some unspecified way.

### 778TH MEETING

The 778th meeting of the Society was held in the Cosmos Club, October 23, 1957, President W. D. JOHNSTON, JR., presiding.

*Program.*—Russian movie: *The fall of Sikhote-alin meteorite.*

W. O. ROBINSON, HARRY BASTRON, AND K. J. MURATA: *Biogeochemistry of the rare earth elements with special reference to the hickory tree.* Hickory trees concentrate the rare-earth group of elements in their leaves to a phenomenal degree, containing as much as 2,300 parts per million of total rare earths based on the dry weight of the leaves. In a general way, the accumulation in hickory leaves can be related to the nature of the country rock of the soils on which the trees grow, the highest values (300 to 2,300 ppm) being found in areas of granites, gneisses and schists, and the lowest (<10 ppm) in certain areas of sandstone, marl and serpentine. Previous evidence of the accumulation of rare earths by plants was offered by Goldschmidt and Peters in 1933 when they found an enrichment of these elements in coal ashes.

The study of the biogeochemistry of these elements has been extended by employing chemical and spectrochemical methods of analysis. Chemical concentrates of the rare earths were made from hickory leaves and from the exchangeable cations extracted from the soils on which the trees grow. The individual rare-earth elements in the concentrates were determined by a spectrochemical DC-arc emission technique.

The average proportions of the individual elements (atomic percent of the total rare-earth elements) in the leaves are Y 36, La 16, Ce 14, Pr 2, Nd 20, Sm 1, Eu 0.7, Gd 3, Tb 0.6, Dy 3, Ho 0.7, Er 2, Tm 0.2, Yb 1, and Lu 0.2. The proportions in the leaves and in the exchange complex of the soil on which the hickory trees grow are very similar, indicating that the trees do not fractionate the rare earths appreciably.

The variation of the rare-earth elements among the leaves and soils can be explained generally in terms of the relative abundance of the yttrium-group and the cerium-group, except for the element Ce. A normal distribution of the cerium-group, as exemplified in igneous rocks, shales, and cerium minerals shows the concentration of Ce about equal to the sum of the concentrations of La and Nd; that is, the ratio Ce/(La + Nd) = 1. This ratio is lower for most of the leaf and soil samples analyzed, indicating that the concentration of Ce is less than in the normal cerium-group materials. Further investigation indicated that the proportion of Ce was correlated to oxidation-reduction conditions in the soil, and led to the discovery that Ce becomes quadrivalent under oxidizing conditions that exist in soils which are low in organic matter, and may become separated

from the other elements of the cerium-group, which undergo no valency change under these conditions. Ce would thus become unavailable to the hickory tree in the oxidized state. This would explain the low values found in the leaves, and in the exchange complex of soils under oxidizing conditions.

An experiment using a chemical agent ($H_2SO_3$) which would reduce any quadrivalent Ce to the trivalent state and also extract the exchangeable cations from a soil low in organic matter resulted in a large increase in extractable Ce, whereas the concentration of the elements which undergo no change in valence have the same relative proportions to each other whether or not a reducing agent is used. The data prove the existence of quadrivalent Ce under oxidizing soil conditions, and show the selective and independent migration of this element.

H. W. OLIVER: *Testing isostasy in California.* The Sierra Nevada affords an excellent site for gravity studies of crustal structure. This mountain range is 400 miles long and 80 miles wide and culminates in Mount Whitney (14,496 feet), the highest point in the United States. The rocks now exposed at the surface are largely granites of Cretaceous (?) age, which have very little near-surface density contrast to camouflage possible gravitational effects due to crustal structure. Moreover, recent seismic studies of the earth's crust in California provide control for resolving the inherent ambiguities of gravity interpretation.

Fifteen hundred gravity stations occupied in the Sierra show a range in complete Bouguer anomalies from −20 mgal at the western edge of the Sierra to a minimum of −240 mgal just west of the Sierra crest, a distance of only 65 miles. Farther east, a positive regional gradient of 1 mgal per mile continues as far as Death Valley. Direct analysis of Bouguer anomalies using seismic data as control indicates that the crust is 30 km thick under the San Joaquin geosyncline; that the thickness increases gradually to 35 km at the western edge of the Sierra Nevada; very rapidly in the western Sierra foothills to a maximum of about 60 km under Mount Whitney; and that farther east, the thickness decreases to 40 km under Death Valley.

Isostatic anomalies corrected for local geologic effects are very close to zero at the western edge of the Sierra Nevada. The central and eastern regions are overcompensated by 40–50 mgal suggesting that current uplift along the Sierra Nevada fault zone may be caused by isostatic forces. However, there is almost no local isostatic response to the 10,000-foot eastern Sierra scarp or to individual ranges east of the Sierra Nevada.

### 779TH MEETING

The 779th meeting of the Society was held in the Cosmos Club, November 13, 1957, Vice-President J. W. GRIEG presiding.

*Communication.*—W. P. WOODRING presented a memorial to JAMES STEELE WILLIAMS.

*Program.*—W. H. HASS: *Classification and stratigraphic range of disjunct conodonts.* Conodonts are the minute laminated toothlike and platelike structures of an extinct, unknown, monophyletic group of marine animals. A natural classification cannot, as yet, be devised but a utililarian classification, of use to the stratigraphic paleontologist, is feasible.

The classification of disjunct conodonts here proposed is based on the fact that each individual specimen was built up through the accretion of lamellae about the pulp cavity, to which all other parts of the structure are referred. The so-called fibrous conodonts (Neurodontiformes) are considered to be altered lamellar specimens. Seven families under the order Conodontophorida Eichenberg, 1930, (Lower Ordovician-Middle Triassic; possibly Upper Cambrian-Upper Cretaceous) are recognized:

DISTACODONTIDAE Bassler, 1925. Pulp cavity surmounted by single, straight or curved, undenticulated fanglike cusp. Lower Ordovician–Upper Silurian, and Devonian(?).

BELODONTIDAE Huddle, 1934. Pulp cavity surmounted by a single, straight or curved, denticulated, fanglike cusp whose base may be greatly enlarged. Lower Ordovician–Upper Silurian.

COLEODONTIDAE Branson and Mehl, 1944. Pulp cavity located beneath main cusp at or near the anterior end of a denticulated bladelike or barlike unit. Lower Ordovician–Middle Triassic.

PRIONIODONIDAE Bassler, 1925. Pulp cavity located beneath main cusp at or near the posterior end of a denticulated bladelike or barlike unit. Lower Ordovician–Upper Pennsylvanian.

PRIONIODONTIDAE Bassler, 1925. Pulp cavity located in middle third of denticulated bladelike or barlike unit. Lower Ordovician–Middle Triassic.

POLYGNATHIDAE Bassler, 1925. Pulp cavity

greatly restricted; platforms flank part or all of axis. Middle Ordovician–Middle Triassic.

IDIOGNATHODONTIDAE Harris and Hollingsworth, 1933. Pulp cavity not greatly restricted so that aboral side of unit is partly or entirely opened up into a large concavity. Upper Ordovician–Middle Permian.

W. G. PIERCE: *Detachment thrusts, with special reference to the Heart Mountain thrust, Wyoming.* Characteristic or significant features of detachment thrusts are (1) their roots are either unknown or non-existent, (2) younger rocks are commonly thrust on older rocks, (3) the thrust masses are very thin in comparison to their horizontal extent, and (4) the thrusts apparently originate along, or tend to follow stratigraphic horizons.

The Heart Mountain detachment thrust, characterized by the above-noted features, has been described by the writer in a recent paper (Bull. Amer. Assoc. Petr. Geol. **41:** 591–626. 1957). Additional evidence subsequently found indicates that the Heart Mountain thrust had two episodes of movement. The first movement, which preceded the deposition of the Crandall conglomerate of early Eocene age and may have initiated the conditions for its development, is shown by several deposits of Crandall conglomerate resting with sedimentary contact on brecciated thrust debris. The second movement of the thrust blocks was after the deposition of the Crandall conglomerate, as is indicated by thrust blocks riding over and resting on other deposits of the Crandall conglomerate.

New evidence also was found pertaining to the initiating force or movement of the Heart Mountain thrust. Prior to the first large movement of the Heart Mountain thrust blocks, rocks belonging to the "early acid breccia" volcanic sequence were deposited on the surface beds—commonly Madison limestone—and then some large blocks of Madison limestone were thrust or otherwise emplaced on these deposits of "early acid breccia." This combined sequence then became detached along the horizon of the Heart Mountain thrust at the base of the Bighorn dolomite and moved southeastward for a distance of several miles. Hence there is evidence of a slightly earlier and less extensive thrust closely associated with the "early acid breccia" volcanism. Following this was the main movement of the Heart Mountain thrust blocks which carried in "piggy-back" style some of the "early acid breccia" and overlying Madison blocks of the earliest thrust to their present position where they were soon engulfed and buried by volcanic rocks of the "early basic breccia" sequence. Thus in a few places, some of the Heart Mountain thrust masses may be seen to consist of Madison limestone resting on "early acid breccia" which in turn rests on the so-called "upper plate" of the Heart Mountain thrust.

### 780TH MEETING

The 780th meeting of the Society was held in the Cosmos Club, November 27, 1957, Vice-President J. W. GRIEG presiding.

*Program.*—P. E. CLOUD: *Extinction.*

E. C. ROBERTSON: *Experimental consolidation of aragonite mud.* Consolidation experiments were made on 165 samples of calcium carbonate sediments from the banks west of Andros Island in the Bahamas. The sediments consisted mainly of needles of aragonite of clay and silt size. Density and crushing strength of the mud were observed as functions of pressure, temperature, and time. The pressures ranged from 30 psi to 500 psi; temperatures ranged from 30°C to 400°C; time periods ranged from 3 hours to 4 days, and a few periods from 1 to 8 weeks. Other important variables such as the amount of water present, the composition and concentration of dissolved salts in the water, the proportions of aragonite and calcite present, the grain size and shape, and the porosity and permeability of the mud, were not tested.

The density of the product shows an anticipated increase with increase of pressure (about 20 percent from 30 psi to 500 psi) for each temperature. Heating of the mud caused a surprising decrease in the final density (about 20 percent from 30° to 400°C), for times up to 4 days, because of an exchange of air for water in the void spaces.

Aragonite is metastable under all conditions of pressure and temperature used in the experiments. In these experiments aragonite inverts to calcite in 1 hour at 450°C under 15 psi and in about 4 weeks at 200°C under 5,000 psi.

The increase of crushing strength of the product is roughly linear with increase of temperature. The effect of pressure on the crushing strength is small, and the effect of time was noticeable only for periods greater than 4 weeks. The crushing strength and density of natural

limestone from various localities in the United States indicate (1) a low strength group, less than 5,000 psi, for densities between 1.2 to 2.0, and (2) a high strength group from 5,000 psi to 30,000 psi and densities from 2.0 to 2.9. The synthetic limestones produced in this study are in the low-strength group. It is suggested that the low-strength group represents calcium carbonate sediments that have been subjected to low temperature-low pressure diagenesis, whereas the high-strength group represents sediments that have been metamorphosed under higher pressure and temperature, possibly for longer periods of time.

D. S. CARDER and L. F. BAILEY: *Seismic wave travel times from nuclear explosions.* A large number of seismograph records from nuclear explosions in the Nevada and Pacific Island proving grounds have been collected and analyzed. The Nevada explosions were well recorded to distances of 6.5° (450 miles) and weakly recorded as far as 17.5°, and under favorable circumstances as far as 34°. The Pacific explosions had worldwide recording except that regional data were necessarily meager.

The Nevada data confirm that the crustal thickness in the area is about 35 km, with associations of 6.1 km/sec speeds in the crust and 8.0 to 8.2 km/sec beneath it. They indicate that there is no uniform layering in the crust, and if higher speed media do exist, they are not consistent; and that the crust between the proving grounds and central California shows a thickening probably as high as 70 or 75 km and that this thickened portion may extend beneath the Owens Valley. The data also point to a discontinuity at postulated depths of 160 to 185 km.

Pacific travel times out to 14° are from 4 to 8 sec earlier than similar continental data partly because of a thinner crust, 17 km or less, under the atolls and partly because speeds in the top of the mantle are more nearly 8.15 km/sec than 8.0 km/sec. More distant points at 17.5 and 18.5°, indicate slower travel times—about 8.1 km/sec. A fairly sharp discontinuity at 19° in the travel time data is indicated. Travel times from Pacific sources to North America follow closely Jeffreys-Bullen 1948 and Gutenberg 1953 data for surface foci except they are about 2 sec earlier on the continent, and Arctic and Pacific basin data are about 2 sec still earlier. The core reflection PcP shows a strong variation in amplitude with slight changes in distance at two points where sufficient data were available.

### 781ST MEETING

The 781st meeting of the society was held in the Cosmos Club, December 11, 1957, Vice-President J. W. GRIEG presiding.

*Program.*—MEYER RUBIN: *New treatment and resulting C-14 dates from the Near East.* A series of peat samples from a bog at McCulloch, Hancock County, Iowa, were separated into a cellulose fraction (NaOH insoluble) and a humic acid-lignin fraction (NaOH soluble) and their ages determined by the radiocarbon method. The results (Table 1) show no significant differences in the ages of the two carbon fractions.

TABLE 1

| Pollen zone | (Age in years) | |
|---|---|---|
| | NaOH insoluble | NaOH soluble |
| Grass | 6,570 ± 200 | 6,580 ± 200 |
| Conif.-decid. | 8,170 ± 200 | 8,110 ± 200 |
| Spruce | 11,660 ± 250 | 11790 ± 250 |

The conclusion is that there has been very little migration of the more mobile fraction (the humic acid). The importance of this to radiocarbon dating is obvious.

However, samples of charcoal from the archeologic site Jarmo, in Iraq, gave ages of 9,040 years for the cellulose fraction and 7,750 years for the NaOH soluble material. It is believed that the charcoal absorbed younger carbon from the groundwater, which was then separated by the processing of the sample.

To prove whether alkaline soils do or do not "wash out" C-14, samples of modern wood were boiled for periods of 1 day and of 1 week, respectively, in a 5 N solution of NaOH and compared with one that was not boiled. Measurements of $C^{12}/C^{13}$ ratio of the $CO_2$ were made with a mass spectrometer by Mrs. Toshiko K. Mayeda, University of Chicago. Results indicated no significant isotope fractionation. It is therefore concluded that alkaline soils or alkaline pre-treatment do not change the isotope ratio to give an erroneous age.

R. J. BRAIDWOOD: The *Post-Glacial boundary and beginnings of the settled village-farming community in the Near East.*

### 65TH ANNUAL MEETING

The 65th annual meeting was held immediately following the 781st regular meeting. The reports of the meeting secretary, treasurer, and auditing committee were read and approved. The Awards Committees presented prizes for the best programmed talks presented during the year. First prize was awarded G. ARTHUR COOPER for his talk, titled *Evolution of the spiny brachiopods* and second prize was awarded JOHN HACK for his talk on *Erosive work of great rainfalls or gully washers in the Appalachians.* Vice-President PAUL AVERITT received the Sleeping Bear Cup Award for his stimulating "pre-communication" discussions while acting as presiding officer of some meetings.

Officers for the year 1958 were then elected:

President: CARLE H. DANE
Vice-Presidents: ALICE S. ALLEN and LLOYD C. HENBEST
Secretary (2 years): PHILIP W. GUILD
Treasurer: MARY E. MROSE
Members-at-large of the Council (2 years): L. T. ALDRICH, HAROLD JAMES and WILLIAM R. THURSTON

The Society nominated L. W. CURRIER to be a vice-president of the Washington Academy of Sciences for the year 1958.

## EREMOTHERIUM, THE GIANT SLOTH

Creature of nightmares was *Eremotherium*, gigantic sloth of the latter part of the Pleistocene or ice age in Panama. It was an enormous animal that walked on all fours but sat upright, propped up by its heavy tail while feeding on the leaves of trees, one of the largest land mammals the world has known. It is described by Dr. C. Lewis Gazin, Smithsonian Institution curator of vertebrate paleontology, in the Institution's most recent annual report. Dr. Gazin collected remains of several individuals in western Panama. He says:

It was truly a creature of tremendous bulk. It may be compared in size with a mammoth or mastodon, but with rather striking differences in form and relative proportions. The length of the animal's body, for example, was much greater than that of the American mastodon, with a very much smaller head, a longer neck, and a long and massive tail. The length of the vertebral column in a particularly large individual was over 16 feet.

The hindquarters were particularly robust. This is shown by the striking increase in the size of the vertebrae from the neck back to the sacrum. The hind limbs, although a little shorter than those of the average mastodon, were of much greater width. The femur, for example, while nearly a yard in length, is a few inches shorter than in the mastodon, but is more than twice the width across the distal portion.

The skull is about 2 feet long, with a comparatively slender snout. The animal had no tusks, but there are five long crowned teeth above and four below, averaging about an inch and a half in diameter. *Eremotherium* possessed long, powerful claws. In locomotion the forefoot carried its weight on the knuckles with the palm and claws turned inward. The hind foot was turned so that in locomotion the weight was carried on the outer side of the foot. The length of the hind foot in one animal, from the bony core of the claw to the heel, measured 36 inches, possibly the greatest for any kind of land animal.

[This giant sloth] probably had no equal among animals of great bulk for grotesque unwieldiness and sluggishness. It seems impossible that it could have survived and evolved in any reasonably competitive atmosphere or environment. The explanation is that together with other edentates they underwent their principal development and specialization in South America, isolated from the more highly competitive herbivores and especially the more aggressive predators, such as the wolves, pumas, and sabretooth cats of the north.

At about the beginning of the ice age, he says, the northern and southern continents became joined by a land bridge—probably at about or not far from the present isthmus of Panama. At that time many of the more progressive northern types, such as horse, llama, mastodon, various carnivores, and rodents invaded South America. At the same time the relatively more primitive South American animals—including the ground sloths—made their way north. They included opossums and porcupines which still survive.

The ground sloths, the glyptodons with their turtlelike armor, and strange, rhinoceroslike toxodons did not survive to present time. Toxodons did not get north of Central America, but certain smaller kinds of ground sloths, however, established themselves as far north as Pennsylvania and Idaho. One of these, from a cave in West Virginia, was described by Thomas Jefferson. The giant ground sloths, probably never came farther north than the Southern States. Some of the best-preserved remains—evidently also of *Eremotherium*—were found more than a century ago on an island off the coast of Georgia. Remains of the gigantic *Eremotherium* have been found at several localities in Panama. They also have been collected in Venezuela, Ecuador, and Brazil, characterizing the more tropical portions of both North and South America during Pleistocene time.